
STRATEGIC NUCLEAR ARMS REDUCTION:

THE BUILD DOWN

In partial fulfillment of the
requirement for the
Master in Public Policy

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13 April 1984

EXECUTIVE SUMMARY

In October of 1983, the United States proposed a new negotiating position in the Strategic Arms Reduction Talks. It combined the Administration's previous START approach with elements of a concept called build down. The principles of this proposal included:

- an immediate ceiling on the number of ballistic missile warheads and on the overall destructive capacity of the strategic forces of both sides at existing levels.
- a guaranteed annual build down in the number of ballistic missile warheads to 5000.
- build down rules that create incentives favoring stabilizing systems - in particular small, single warhead ICBM's -- and penalize destabilizing systems such as MIRVed ICBM's by requiring the destruction of more than one warhead for each new warhead on a MIRVed system.
- a second guaranteed annual build down in the overall destructive capacity of the strategic forces, missiles and bombers.

The Soviet Union rejected an offer to discuss this concept. There was no subsequent progress in the START talks and negotiations were suspended in December of 1983. The present pause is an opportunity to re-examine the build down proposal and to assess its implications for stability of the nuclear deterrent, aggregate numbers of nuclear weapons, relative force capability, negotiability, and verifiability.

This paper addresses the question: Should the United States adopt the build down framework for strategic arms control policy, and if so, what kind of build down is preferred? The analysis focusses on criteria which measure relative force capability, and stability of the nuclear deterrent, with some treatment of negotiability. Verification is mentioned only briefly.

KEY FINDINGS

In General

- Build down allows modernization to encompass all systems currently planned by both sides, but requires earlier retirement of present systems. Depending on assumptions regarding the desired mix between ICBM, SLBM, and bomber weapons, lower numbers of some new systems may be necessary under build down, and procurement schedules may need to be slowed.
- The build down cannot reconcile a nominal MX deployment schedule and reductions in ballistic missile warheads with a more stable nuclear deterrent. Deployment delays or limitations in the scope of U.S. strategic force modernization can result in a more stable deterrent while still providing the United States with margins of advantage in the capability of build down constrained forces.
- The force structures of the two sides, (the percentage of ballistic missile warheads on SLBM's versus the percentage on ICBM's), converge under build down more than in the event of unconstrained modernization.

Limited single build down

- Of the two rules requiring warhead reductions, the guaranteed 5% minimum reduction per year is most often the binding constraint on force planning. The variable ratio rule rarely requires larger reductions than the 5% minimum.

Comprehensive double build down

- If double build down is negotiated on the basis of standard weapon station proportionality factors rather than throwweight, a Soviet push for higher factors could result in inadequate compensation for U.S. long range bomber reductions in the form of Soviet heavy ICBM reductions.

ASSUMPTIONS ...

... about Modernization Plans

If modernization is not constrained by arms control, the United States will proceed with deployment of the MX and Midgetman missiles, Trident submarines with D5 missiles, the B-1B and Stealth bombers, and various cruise missile programs. The Soviet Union will deploy the SS-X-24, the SS-X-25 small missile, more Typhoon submarines, and the ALCM equipped Blackjack bomber. It is assumed that the basing modes for MX, Midgetman, SS-X-24, and SS-X-25 are not finalized; likely prospects include dispersed, multiplicity, or superhardened silo basing, some combination of these, or mobile basing.

... about Specifics of Build Down

The build downs are divided into two types for analysis: the limited single build down and the comprehensive double build down. The Administration's October 1983 proposal combined these two approaches. Since they have different origins, and spring from different motivations, it is useful to examine them separately.

The limited single build down is characterized by build down ratios which provide incentives to move away from destabilizing systems. The key aspects of this plan are:

- A build down in ballistic missile warheads (hence 'single') to 5000 on each side.
- Reductions in each year by build down ratios or by 5 percent, whichever results in larger cuts.
- Build down ratios which prescribe the number of existing warheads to be retired for each new warhead deployed: 2:1 for MIRVed ICBM's, 3:2 for SLBM's, 1:1 for single RV ICBM's.
- Bombers to be reduced by a separate build down (hence 'limited') or other scheme. In this paper bombers are assumed to be limited by the terms of the most recent START proposal.

The comprehensive double build down was conceived in the summer of 1983 as a more prescriptive means of reducing throw weight than the single build down, and is characterized by:

- A build down in ballistic missile warheads and standard weapon stations (SWS) to 5000 and 8500 respectively (hence 'double').
- Reductions in each year to be determined by a straight line from present levels to the 5000/8500 plateaus; reductions are not driven by modernization, as in the single build down.
- bombers are included (hence 'comprehensive').

... about Counting Rules

SALT II counting rules are used for warheads and launchers. In calculating relative force capabilities, actual numbers of weapons are used in place of SALT II totals, which are higher than the number of weapons deployed on some of the strategic systems.

ANALYTIC METHOD

The analysis proceeds through two phases, yielding results from which judgments are made about force capability and stability of the nuclear deterrent. The phases are build down of forces and counterforce exchange. Both functions are performed using Supercalc electronic spreadsheet software on a personal computer. The build down involves imposing a prescribed set of reduction rules on the forces of both sides, and modernizing within these rules. Subjective decisions are made regarding rates of deployment and retirement.

The counterforce exchange model is used to reveal the relative capabilities of forces, as measured by ratios and absolute margins of advantage. There are weaknesses associated with this approach, the most prominent of which are:

- counterforce exchange does not address most of the contingencies in which nuclear weapons might be used.
- the response to a counterforce attack is not necessarily a counterforce retaliation.
- the concept of relative advantage is slippery, and its worth depends in large measure on personal notions of what deterrence is, and how it operates.

RESULTS

Both the single and double build downs result in a less stable nuclear balance if modernization programs proceed at the rates now planned. However it is possible for the United States to maintain a substantial relative advantage in various measures of force capability after a counterforce exchange, even if MX deployment is slowed to 10 per year. This is true even if the Soviet Union were to strike first. Such a slowdown would result in fewer ICBM silo retirements in the early years of a warhead build down than would be necessary under nominal deployment rates. This would mitigate a situation which would otherwise occur in the early 1990's of the number of land based silos on the U.S. side dipping below 300. The slowdown allows for MX deployment to overlap with D5 deployment, thus smoothing the transition to greater reliance on sea based hard target kill capability. Such a slowdown would take place only if Soviet force planning were also constrained by build down.

Build down is especially valuable politically because it allows members of Congress to endorse arms control positions different from those they had previously taken. For example, double build down is an opportunity to endorse throw weight reductions by another name. Build down has also provided a vehicle for political reconciliation between nuclear freeze advocates and modernization advocates.

RECOMMENDATION

- Retain build down as an element of the U.S. START negotiating position.
- Pursue the double build down using explicit limits on throw weight as a point of negotiation rather than the proportionality constants which define the standard weapon station.
- Remove the variable ratio rule as an element of the proposal unless it is changed to include bomber weapons.
- Continue to press for immediate ceilings on ballistic missile warheads and standard weapon stations, and guaranteed annual build downs of both.
- Do not present proposals which prohibit or discourage basing modes which might enhance survivability of ICBMs.

Difficulty may arise from the effort to achieve reductions in Soviet ballistic missile throw weight as compensation for reductions in U.S. bomber gross take-off weight. The SWS, which provides the means to equate these quantities, should not be the focus of negotiations, because the Soviet Union will very likely push for proportionality constants which reduce the number of SWS per heavy missile. Such a result would diminish the utility of the SWS for making possible a trade of U.S. bomber reductions for Soviet reductions in heavy missiles.

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SECTION ONE
STRATEGIC NUCLEAR BUILD DOWN: BACKGROUND

1.1 Status of Proposals

In the first Soviet reaction to President Reagan's arms control proposals of 4 October 1983, Tass said that the suggestions were "nothing but words." These suggestions included a 'mutual guaranteed build down', the result of many months of negotiating between the Reagan Administration and members of Congress. The language the Soviets used to express refusal did not indicate unwillingness to discuss build down so much as it did the generally poor climate for arms control in the fall of 1983. When nuclear arms reduction talks resume, the build down is likely to be on the agenda.

The current pause in START negotiations is an opportunity to re-examine the build down concept, to consider whether any combination of build down rules constitute acceptable means to ensure U.S. security while reducing the number of nuclear weapons and enhancing stability of the nuclear deterrent.

The build down is important in part because it has influential adherents in the Congress. The October 4th START position, which included build down, was so much the result of efforts by members of Congress concerned with arms control, that pressure for the President to persist with some form of the plan is likely to continue. The President must at least obtain Congressional approval for any arms control treaty he may sign. A lesson from SALT II is that the negotiating position of the United States must be formulated with sensitivity for domestic political opinion, in order to improve the prospect that a signed treaty will receive the approbation of the American public, and ratification by the United States Senate.

The words "build-down" have come to mean many different things; build down now connotes any arms control scheme which combines strategic modernization with reductions in the aggregate number of nuclear weapons. As it was first conceived, the build down provided incentives for both sides to shift their forces away from heavily MIRVed land-based ICBMs, toward less destabilizing systems. This paper examines two types of build down: the limited single build down (by warheads only, excluding bombers), and the comprehensive double build down (by warheads and destructive capability, including bombers).

1.2 Organization of the Paper

What follows is a comparison of build downs primarily by criteria of force capability and strategic stability. The present section describes Congressional antecedents of the build down. The Analytical Method section states objectives for the analysis, and enumerates criteria for the evaluation of build down plans. The methodology for application of the criteria is presented, including a description of a counterforce exchange model. In section three, Analysis of Build Down Alternatives, the two classes of build down are evaluated using the method described in section two. Sensitivity analysis is used to examine the significance of changing several assumptions. Section Four contains recommendations.

1.3 Congressional Development of Build Down

Alton Frye of the Council on Foreign Relations is often credited with originating the notion of the strategic nuclear build down. At the heart of the idea is the requirement that a heavy price be paid in existing strategic warheads to 'buy' new warheads. The development of build down was inspired by the Scowcroft Commission recommendation that "our arms control proposals and our strategic arms programs should be integrated and mutually reinforcing." The reconciliation of two apparently conflicting aims, greater stability and modernization, was thought impossible by advocates of the nuclear freeze. Build down is an attempt to bridge the political gap between advocates of unrestrained modernization and proponents of the freeze.

In January of 1983, Senator William Cohen (R-Me) co-sponsored a resolution with Sam Nunn (D-Ga) (S. Res. 57) calling for "a balanced blend of force modernization and force reduction" by both governments. The Senators felt this goal could be served by a mutually guaranteed build down of nuclear forces, to require each side to eliminate from its operational forces two nuclear warheads for each newly deployed warhead. This penalty for new and destabilizing systems, especially MIRVed land-based ICBMs, was to be imposed while allowing 'freedom to mix,' by which the U.S. or U.S.S.R. could buy one MX warhead by retiring two sea-based warheads, or vice versa. Incentives to make modernization of sea-based systems more attractive than ICBM modernization could be provided by enforcing a more favorable build down ratio for SLBMs (ex. 3:2); this would be done in the interest of stability, since SSBNs at sea are relatively invulnerable to first strike attack. Senate Resolution 57 also called for the use of SALT II counting rules and implementation procedures, and for agreed verification measures. No mention was made of including or excluding different systems, so the 2:1 could be applied to all new warheads, sea-based, land-based, or bombers. The specific means by which to do this were not initially prescribed, but evolved over the following months. Table 1-1 summarizes subsequent modifications of the build down, which are described below. [All Tables and Figures appear at the end of the text.]

In April, Senators Cohen, Nunn and Percy sent a letter to the President calling for a reformulation of the U.S. START position, development of a meaningful build down proposal, a firm commitment to development of a small single warhead ICBM, and creation of a durable, bipartisan arms control panel. They tied their votes on the MX to acceptance of this plan.

In a June 22nd statement, Senator Cohen called for the build down to be applied comprehensively, to include all three legs of the triad. The ceiling on warheads was to eventually be 5000, plus an allowance for 'other strategic systems', meaning bombers. Each side was to build down under agreed ratios until reaching a negotiated floor or plateau, at which it would hold. When the other side reached the same plateau, the build down formula would again take effect. This element was included as a hedge against the possibility that the Soviets would decide against modernizing their forces under a build down, thus escaping reductions while the U.S. proceeded with its modernization program. The Cohen build down was intended to complement START rather than replace it. Because of its simplicity, build down was thought to be relatively easy to reach agreement on, to be followed by pursuit of the "more complicated long term objectives of START."

By September the single build down by warheads only had been modified by adding the notion of limiting destructive capability. In a letter to Brent Scowcroft, Senators Cohen, Nunn and Percy called for a reduction in both sides' overall destructive capacity in a manner that recognized the different nature of bombers and missiles. Air Force General Glenn Kent (retired) proposed such a double build down reduction scheme based on a standard weapon station, which equates units of destructive capacity in all strategic nuclear systems. While the incentive feature of the original build down remained (reducing missile warheads in such a manner that both sides would have inducements through the ratios to move away from large MIRVed ICBMs), the concurrent plateaus gave way to the more stringent constraint of a guaranteed annual build down in the number of ballistic missile warheads.

1.4 Executive / Congressional Negotiations on Build Down

Simultaneously there were separate arms control initiatives emanating from the House of Representatives, notably from Les Aspin, Albert Gore, and Norm Dicks. The Gore proposal of 22 August defined a two stage reduction/modernization approach. The Senators involved decided to explore with their House colleagues a joint approach to the Administration. What evolved was a set of principles including a commitment to revise the START position along the lines of the Scowcroft Commission recommendations. They called for an agreement which:

- Was simple, credible, negotiable.
- Put a cap on and reduced ballistic missile warheads and total destructive capacity.
- Reduced missile throwweight and bomber payload in a manner consistent with stability.
- Reduced in favor of stabilizing systems, with penalties for destabilizing systems.
- Paced each sides modernization program by an annual percentage reduction.

A negotiation in September resulted in the President endorsing these principles. On October 4th the President delivered a new strategic arms proposal to Edward Rowny, the chief American negotiator, who subsequently carried it to Geneva. This proposal involved a two stage approach:

Stage I: Continuation of START

- Reduce missile warheads to 5000.
- Devise a formula to close the 3:1 Soviet throwweight advantage.
- Drop the subceiling of 2500 land-based missile warheads within the overall 5000 warhead limit.
- Reduce the bomber fleet to less than 400.
- Limit ALCM deployment to 3500 instead of 8000.

Stage II: Build down

- Conduct parallel talks in a separate working group.
- Negotiate an annual cut of 5% in missile warheads or a reduction based on a build down formula, whichever is greater.
- Use build down ratios of: 2:1 for ICBMs, 3:2 for SLBMs, and 1:1 for single RV ICBMs.

The following sections analyze the results of imposing several forms of build down on Soviet and American forces.

SECTION TWO ANALYTIC METHOD

2.1 Objectives for the Analysis

The principal objective of this analysis is to determine whether the United States should pursue a build down framework for strategic arms control, and if so what kind. The motivation is to identify arms control regimes which enhance stability of the nuclear deterrent. The recommendation is based primarily on criteria of stability and relative force capability.

Another objective of this work has been to develop analytical tools for evaluating arms control proposals which can be easily implemented on a personal computer. These tools are intended to facilitate sensitivity studies, for example to simplify the comparison of relative capabilities under arms control of forces in various generated and non-generated alert postures.

The tools were developed especially for decision makers who do not always have time to commission studies of arms control alternatives but must quickly develop answers themselves. Though there are limitations in the methodology used, by keeping these in mind, the techniques can be useful for evaluating strategic force structures. The tools do not impute decisions about which new weapon systems to deploy, how quickly to deploy them, retirement schedules, or similar considerations. Such decisions are made subjectively. The tools do help to count measures characteristic of the strategic nuclear forces (warheads, launchers, standard weapon stations, etc.) as an aid to the decision maker in sorting out the implications of different arms control regimes.

2.2 Criteria for Evaluating the Build Down

The build down plans are evaluated using criteria of force capability and stability of the nuclear deterrent. Force capability refers to the effectiveness with which the strategic nuclear force could be used to fulfill military missions in the event deterrence failed. Stability depends on inhibitions to using nuclear weapons, especially in time of heightened alert.

This analysis assumes that stability depends on marginal changes in relative force capability, and that deterrence depends directly on the threat to use nuclear weapons which are known to be capable of causing the threatened damage. There are alternative views of deterrence, notably that stated in the Catholic bishops pastoral letter of May 19, 1983. The bishops believe deterrence to be independent of any particular theory of war fighting, and to be inherent in deployments already made. The analysis below, which cites margins of advantage, is inconsistent with this existential notion of deterrence.

This paper presents the results of hypothetical counterforce exchanges, and does not address the implications of build down for a full range of strategic nuclear strategies. This is indicative of the weaknesses in methodological assumption, which are discussed further in Appendix A. The qualifications presented there are ones of which the reader should be mindful when evaluating the conclusions of this analysis.

2.3 Types of Build Down Considered

Figure 2-1 shows the essential elements of the two types of build down considered: the limited single build down, and the comprehensive double build down. "Limited" refers to the exclusion of bombers from the plan, and thus to limitations on the freedom to exchange warhead retirements in one segment of the strategic force for modernization in another. Conversely, "comprehensive" indicates the inclusion of all three triad legs in build down, with complete freedom to mix. "Single" refers to the 'warheads only' measure by which to count forces as they are reduced; "double" pertains to a build down by two measures, standard weapon stations and warheads. The use of 'limited', 'comprehensive', 'single', and 'double' suggest general types; it is possible to imagine a single build down by standard weapon stations, or some other metric, that includes bombers but prescribes some asymmetry in the freedom each side has to mix. Phase I of the Gore proposal of August 1983 is such an example.

Two plans of current interest embody the types described: the single build down component of the arms control proposal put to the Soviets in October 1983, and the double build down, conceived by Air Force General Glenn Kent (retired), which was also part of the October package. The following analysis considers these plans separately, and examines the sensitivity of conclusions regarding relative force capabilities to such changes in assumption as cancellation of modernization programs, generated versus non-generated alert, and increases in average Soviet target hardness.

The limited single build down includes reduction ratios of 2:1 on ICBM warheads, 3:2 on SLBM warheads, and 1:1 on single warhead missiles, and a requirement for a minimum reduction of five percent per year in ballistic missile warheads. The Kent double build down requires linear reductions in warheads and standard weapon stations from levels of approximate parity in 1984, to equal ceilings of 5000 ballistic missile warheads (from present levels of about 7500) in eight years, and 8500 standard weapon stations (from present levels of about 15,000) in twelve years.

2.4 Description of Methodology

2.4.1 Build Down Worksheet Described

Figure 2-2 shows in block diagram form the methodology by which build down proposals have been evaluated. The task begins by listing existing forces, and gathering information regarding modernization plans, the systems, rates of deployment, and rates of retirement. Next comes imposition of the build down, year by year, from 1984 to 2000. To facilitate the repetitive calculations involved, an electronic spreadsheet was constructed in Supercalc, on a personal computer. Figure 2-3 is an example of this worksheet for U.S. forces. (See also Appendix B.) The top portion shows the number of ICBMs and SSBNs in the force at the end of each calendar year. The center of the sheet lists changes in accounting warheads for each system. If one MX is deployed with a 2:1 ICBM reduction ratio in force, the accounting warhead gain equals $(2) \times (20) = 20$. Twenty warheads on older systems must then be retired in order to meet the build down requirement. The bottom portion of the worksheet shows summary figures for 'accounting' warheads and 'real' warheads. This particular example illustrates reductions consistent with the October 4th

limited single build down, which requires a five percent minimum reduction per year, or reduction by variable ratios, whichever results in larger cuts, until a plateau of 5000 ballistic missile warheads is reached. In this example the United States deploys 100 MX missiles, 500 single warhead missiles and 18 Trident submarines fitted with the D5 missile.

Many characteristics of the strategic forces can easily be tabulated using this technique. Other forms of the worksheet have been constructed to include calculation of bomber weapons, silos, standard weapon stations, and similar information. Appendix B contains a sample double build down for Soviet forces in 1986, explaining the details of the build down process.

2.4.2 Build Down Worksheet: Subjective Decision Rules

The worksheets are most often configured to count accounting warheads and warhead percentage reductions (for the single build down), or warheads and standard weapon stations, (for the double build down). In working through each case, choices are made about which reduction rules apply, and about reasonable evolution of the forces in light of factors like inter-service rivalry and domestic political exigency. Table 2-1 lists some of the subjective decisions involved in using the build down worksheet. Table 2-2 depicts some of the constraint parameters from which a set of reduction rules is chosen. In structuring a sensitivity analysis, the subjective assumptions and constraint parameters are chosen to yield a set of reasonable force modernization outcomes under build down; the implications of build down for stability of the nuclear deterrent are investigated in this way.

2.4.3 Method for Determining Force Capabilities

Having arrived at force structures that satisfy build down, the next task is to determine how to compare the capabilities of the resulting forces. One commonly used method is by ratios of hard target kill capable warheads to enemy hard targets. However this is often a misleading measure, because it is not weighted by the fraction of warheads in silos, or some other factor which reflects that its importance is proportional to the number of warheads threatened. Nor does it account for the different vulnerability of land and sea-based hard target killers, which is an increasingly important consideration for strategic stability as the Trident II (D5) missile is deployed.

A more useful approach determines relative nuclear capabilities by trends of various indices like warheads, standard weapon stations, equivalent megatonnage, and effective countermilitary potential. These are measures intended to simplify calculations of force effectiveness, by aggregating the capabilities for attacking a variety of target types across the entire strategic force.

Estimating countermilitary and countervalue capabilities is an uncertain business. There are quite a variety of measures of countervalue capability (for attacks against soft point and area targets) including megatonnage and equivalent megatonnage. Examples of aggregate measures of countermilitary capability (for attacks against hardened silos, launch control centers, and other military targets) include hard target kills, throwweight, countermilitary potential, and number of warheads. Some measures are intended to be useful in combining the assessment of countermilitary and countervalue

capabilities; equivalent weapons, relative force size, and time trends of various measures are among these. Even skeptics of the validity of individual aggregate measures will agree that combined trends are useful, since the direction of change in the aggregate measures tend to be correlated with force capabilities.

This 'static measures' approach does not account for targeting concerns, reliability, alert rates, and other operational characteristics of the forces. For this reason, the analysis of forces in this paper continues through a three step process, which includes modelling a counterforce exchange. This approach involves calculating:

STEP 1: the force that each side has before a strike (static indicators).

STEP 2: the force surviving to the US (USSR) and that remaining to the Soviet (US) side after an initial counterforce strike by the Soviets (Americans).

STEP 3: the force remaining to each side after an exchange in which the Soviet (US) side attacks US (Soviet) forces and the United States (USSR) responds by reducing Soviet (US) reserve forces to the greatest extent possible.

2.4.4 Description of Aggregate Measures

The pre-strike forces are described by trends of effective countermilitary potential, equivalent megatonnage, standard weapon stations, ballistic missile throwweight, and number of weapons. Effective countermilitary potential (ECMP) is a variant of countermilitary potential (CMP), the most widely used aggregate measure of countersilo capability. ECMP is corrected for arrival probability, which is not adequately treated in the formulation of CMP. To aggregate across the strategic forces, the ECMP of all weapons is added together. Therefore many weapons are included which are not accurate enough to be used against hard targets, and would not be so targeted. The exact formulation of ECMP appears in Appendix C.

Equivalent Megatonnage is used as a measure of urban-industrial damage because it is proportional to the amount of area that can be destroyed by blast effects. For this metric to accurately represent the capability of a force against area targets, it should be that the lethal area of the weapon matches the lethal area of the target, and that all area targets be of equal importance. These conditions are rarely met, so EMT is a biased measure of countervalue damage potential. However it is better than using megatonnage, and is included in the following analysis.

The Standard weapon station is an aggregate measure of destructive potential formulated on the basis of ballistic missile throwweight and bomber gross takeoff weight. The missile throwweights are divided by the nominal throwweight associated with a modern reentry vehicle to derive the number of SWS per strategic nuclear missile. Specific rules by which the SWS is derived are discussed in Section 3.1.1. One of the advantages of SWS over throwweight is that it incorporates the average weight of reentry vehicles, and thereby carries a more intuitively clear meaning than throwweight. It assumes that the throwweight per MIRVed RV is tending to an average of 400 kg on both sides, that an ALCM equipped B-52 bomber has twice the number of SWS of a non-

ALCM B-52, and that an ALCM equipped B-52 is the equivalent of a MIRVed SS-18 in destructive potential.

Ballistic missile throwweight is roughly correlated with both megatonnage and EMT, and is often used as an indicator of countervalue capability. The correlation is lower for multiple warhead missiles than for those with a single warhead. Throw weight is thus better used to gauge the potential for MIRVing a missile than for describing its countervalue capability. The advantage of throwweight is that it can be estimated by national technical means, and is thus relatively more easy to verify in the context of arms control than measures which are specific to warhead characteristics.

The number of weapons, both ballistic missile warheads and bomber weapons, is the unit of account for the pre-build down United States START proposals. This represented a change from SALT II procedure, which specified the number of warheads per missile, then placed ceilings on the number of various launcher types. START/build down accounting is in weapons; the double build down adds counting by standard weapon stations.

2.4.5 Pre-Attack Balance of Forces

Trends in aggregate measures can indicate whether the forces resulting from build down leave one of the sides with a relative advantage, and in whose favor the advantage is tending over time. The difference is taken between aggregates for each side, and is plotted by year. An example of this is Figure 3-6 which will be discussed in section 3.1.3.1 in connection with the double build down. The trends of various measures are plotted on a single graph, whose ordinate is in various units; this approach is used for convenience of presentation. Figure 3-6 shows the United States gaining or maintaining relative advantages in four of the five aggregate measures, and significantly diminish the Soviet advantage in ballistic missile throwweight.

2.4.6 Counterforce Exchange Model

This model calculates the alert forces on each side, assigns these forces to targets (silos, launch control centers, bomber bases, and SLBM ports), and calculates damage expectancy. Once the decision is made about which side strikes first, the alert forces on both sides are calculated for each year, based on the available forces (output of the build down worksheet) and the alert status (day to day or generated).

The attacker's warheads are assigned to the most valuable targets first, using warheads having the best overall probability of kill (OPK). The assignment process continues, covering targets of decreasing value with warheads having the highest remaining OPK against that target type. Targets are assigned two warheads each, except for single warhead targets, which are assigned only one.

In its most general form the model uses a 'pricing' scheme; the price to attack each target is calculated in warheads, standard weapon stations, or some other metric. To attack a hardened silo containing a MIRVed missile the nominal price is two warheads, which must be paid whenever sufficient warheads are available to the attacker. If only single warhead missiles are left in the attacking force, only one warhead can be assigned per target. In the case of a barrage attack on a dispersed force of hardened mobile launchers, a

certain price in standard weapon stations per launcher can be calculated, and this price must be paid in assigning forces to targets. By using the pricing mechanism, it is possible to investigate the implications of measures to decrease ICBM vulnerability such as the deployment of hardened mobile launchers, multiplicity basing, closely spaced basing, and superhardening.

Based on the number of targets covered and the overall probabilities of kill, the force surviving to the opponent can be calculated, as can the force remaining to the attacker. The proportion of bomber and submarine forces available for use depend on the level of alert, and whether a side is attacking first or retaliating. (see Appendix D for a more detailed explanation). A cookie-cutter damage assessment is used, which means that targets are either destroyed or not: they are never damaged in ways which might be repaired quickly enough so they could be used in retaliation. There are two stages at which results from the model are evaluated: after a first strike, and after the exchange is completed.

2.4.7 Comparison of Alternative Indices of Capability: Post First Strike and Post Exchange

The post first strike (Figure 3-7) comparison of capability indices shows the forces remaining to the attacker and those surviving to the victim in trends of five aggregate measures. These plots show the temporary balance of forces, assuming the side that was attacked did not launch under attack. This intermediate result is useful for comparing the absolute aggregates of the two forces, rather than their relative differences.

The post exchange result is yet more interesting, because it is by comparing this with the pre-attack balance of forces that observations are made about changes in incentives to strike first (with the qualification that the game-theoretic notion of deterrence implicit in such observations is not universally thought to be appropriate). This figure shows the result of a counterforce exchange initiated by the Soviet Union with forces constrained by a double build down. It is discussed more fully in section 3.1.3.3.

2.4.8 Margins of Advantage

There are several ways to express margins of advantage in terms of aggregate measures. One is by a difference calculation, the result of which is shown in figure 3-8, another is to calculate ratios of advantage. This is done by dividing the aggregate measure of one force by that of the other, with advantage shown for the side with the greater aggregate. Such a result is Figure 3-9, which shows the United States with an increasing ratio of advantage in SWS and EMT over the next 15 years under double build down, based on a U.S. first strike under day to day alert conditions. It is on the basis of these calculations that judgments are made about the desirability of build down by the criteria of deterrent adequacy and stability.

Some analysts contend that one side might strike first in time of heightened alert in order to improve its post-exchange ratio of advantage in countervalue capability. The goal would be to subsequently coerce the opponent to capitulate, or to prevent the opponent from using this strategy himself. But beliefs about deterrence color beliefs about the relevance of ratios of advantage. Someone who believes that deterrent credibility depends fundamentally on flexible response options, based on well specified attack

plans, may consider the ratio approach more useful for thinking about changes in the deterrent, than someone whose view of the deterrent is existential. The latter may believe that survival of very few weapons on either side is sufficient to make coercion based on the threat of attacking cities incredible, because the deaths in strikes against cities would be far more numerous than in an exhaustive counterforce strike. These caricatures of opposite positions are presented to make the point that it is important to consider both ratios of advantage and absolute numbers of surviving forces in judging how the incentive to strike first may change.

SECTION THREE ANALYSIS OF BUILD DOWN ALTERNATIVES

This section contains a description of the comprehensive double and limited single build downs, and calculations of the capabilities of forces remaining under these regimes, using the methodology of Section Two. Following the double build down description is a section on sensitivity analysis, which examines cases of limited modernization, generated alert, and increased average Soviet silo hardness.

3.1 COMPREHENSIVE DOUBLE BUILD DOWN

3.1.1 Introduction

This type of build down was proposed in the summer of 1983 by Air Force General Glenn Kent (retired). Kent was motivated to frame an arms control proposal which reduced ballistic missile throwweight, and normalized destructive potential across strategic systems. He suggested the standard weapon station as the appropriate metric, and defined it so as to be able to equate reductions in Soviet heavy missiles with compensating reductions in U.S. long range strategic bombers. The comprehensive double build down was a part of the package put forward in the October 1983 START/build down proposal to the Soviet Union.

The key aspects of the double build down are comprehensive limits on strategic offensive arsenals, including ICBMs, SLBMs and strategic bombers, a common currency for potential destructive capacity measured in standard weapon stations, and compulsory annual reductions in both aggregate destructive potential and the number of ballistic missile RVs to a level of 8500 standard weapon stations and 5000 ballistic missile RVs. (See Figure 3-1). The number of standard weapon stations per delivery system is the largest of the number of weapon stations declared, the maximum number of stations tested or configured, the throwweight of a MIRVed missile in Kg divided by 400 (500 for a single RV missile), or the take-off gross weight of bombers (in pounds) divided by 25,000 (w/ALCM) or 30,000 (w/o ALCM).

The throwweight divisors (called K factors by General Kent) are defined so that the U.S. and Soviet sides would start the build down with equal SWS totals; this can be seen in Figure 3-2. As the ballistic missile K factor is changed from the 400-500 range while holding the bomber K factors constant, one side or the other ends up with more SWS in its force. If K factors are a point of negotiation, the Soviets will prefer higher factors so that they will be obliged to smaller reductions under the double build down. Table 3-1 shows the derivation of standard weapon stations for both forces.

3.1.2 Build Down Worksheet Results

3.1.2.1 Intercontinental Ballistic Missiles

United States Figure 3-3 shows the ICBM forces that might result under the double build down. Although this set of forces is only exemplary, it is intended to be a plausible scenario were the double build down agreed to by the terms described above. Notice that the diagrams for the two sides have

different scales. This allows a clearer picture to be drawn of U.S. ICBMs than would result if the scale appropriate to Soviet ICBMs were used for both. The need to use different scales emphasizes the asymmetry between the forces: the U.S. has about twenty percent of its ballistic missile warheads on land based missiles, the Soviet Union seventy five percent.

During build down, the U.S. retires the Minuteman III (Mark 12) and Titan II missiles, reduces the number of Minuteman III (Mark 12A) missiles from 300 to 100, and reduces the number of Minuteman II missiles from 450 to 100. Also during this period, MX deployment proceeds at a rate of 10 missiles per year; this is a slower schedule than that presently planned, which calls for 100 MX by 1989 or 1990. The Titan II missiles are retired by 1987.

The Minuteman II force is only partially retired, so that some of its relatively large warheads can be maintained for assignment to moderately hard targets and soft-large area military and industrial installations which require high yield but less than pinpoint accuracy. Once the build down ceiling of 5000 ballistic missile warheads is reached, the reduction constraint on the forces is the requirement to drop to 8500 SWS by 1996. New ballistic missile warheads can be added at the price of retiring equal numbers of old warheads (maintaining the 5000 limit) so long as enough bombers are retired that the prescribed annual cuts in SWS are met. The United States has chosen, in this example, to complete the deployment of 100 MX, and to deploy 500 Midgetman missiles.

Soviet Union The Soviets choose to meet the build down requirements by retiring all of the older single warhead SS-11s and SS-13s, all of the SS-17 missiles (which fulfill similar missions to the Minuteman II) and some portion of the SS-18 missiles. The full complement of SS-19s, the most capable hard target kill capable systems in the present Soviet force, are maintained intact, although plans to expand their numbers are dropped.

After 1992, when only the SWS build down is in force, the Soviets further reduce the number of SS-18s in order to deploy the SS-X-24, the new missile allowed to them under the provisions of SALT II. The SS-18 force could be refitted with fewer, larger warheads to serve countervalue missions, although this is not assumed in the calculations below. The solid fuel SS-X-24, for which initial operational capability (IOC) is 1993 in this example, is projected to reach a full operational capability (FOC) of from 200-600 missiles by 1996 in the absence of arms control. Thus the double build down requires postponement and reduction in deployment of this missile.

Although it is unlikely, the Soviets might place even less reliance on submarine forces than they do now, in which case the ICBM force would be larger than that shown here, since the double build down allows complete freedom to mix. If instead the Soviets chose to expend more on sea-based strategic nuclear forces, the ICBM force must be smaller than shown here.

The Soviets add 200 of the SS-X-25, a smaller number than they are likely to deploy in the absence of arms control. This is expected to be a missile of greater throwweight than the Midgetman, but is counted here and in subsequent sections as being armed with a single warhead.

3.1.2.2 Submarine Launched Ballistic Missiles

United States Figure 3-4 shows the composition of sea-based strategic nuclear forces for the United States and the Soviet Union. The U.S. side decreases the proportion of its ballistic missile warheads on submarines from 71 percent to 61 percent by the year 2000. In the years to 1989, the reductions in SLBM warheads are about equal to the yearly cuts in ICBM warheads. From 1990 to 1997, SLBM reductions are greater than ICBM reductions, and from 1992 on, SLBM reductions make possible deployment of the Midgetman missile. After 1992 the 5000 warhead plateau has been reached, and so any additions to ballistic missile warheads must be balanced by an equal number of retirements. During the period 1992-1995 the standard weapon station compulsory build down constrains force deployments, and bombers are cut to meet this requirement. Any net reductions in ballistic missile warheads for the purpose of meeting the SWS reduction requirement would result in fewer than 5000 of such weapons in the force -- it is assumed that neither side would want to reduce below the 5000 plateau.

Over the next fifteen years, the U.S. moves toward a sea-based force comprised increasingly of Trident submarines. The first eight of these are fitted with C4 missiles. After 1988, newly constructed Tridents are fitted with the hard target kill capable D5, while the first 8 Tridents are backfit with the D5. By the year 2000, the U.S. SLBM force consists solely of 16 Trident submarines with D5 missiles. Note that the D5 is assumed here to have 8 MIRVs, although some sources quote plans for 10-15. Obviously the result of build down on the number of Trident submarines will depend on the number of MIRVs per missile. The exemplary build down would force the change of present plans to build 20 Tridents, as well as requiring the retirement of Poseidon submarines well in advance of their presently scheduled retirement dates.

Soviet Union Soviet submarine warheads are reduced by 20 percent at the same time that ICBM warheads are reduced by 44 percent. In 1984 the SLBM force contains 24 percent of all ballistic missile warheads, a proportion which goes up to 53 percent by 2000. The change in force structure is accomplished by different rates of retirement in the different components of the triad, and the warhead composition of the SLBM force changes only slightly. The Yankee subs are retired, as are some of the Delta IIs, and one additional Typhoon is deployed in 1994. Older submarines are retained on the assumption that the Soviets will prefer to maintain some minimum number of subs rather than go to a very small force armed with MIRVed missiles.

Of course it may happen that the SLBM force is modernized more vigorously, at the expense of ICBM modernization. The judgment in this example is that the Soviet Union will continue to depend heavily on ICBMs because of the difficulty in assuring open sea lanes from the relatively few SLBM ports to patrol areas, and because of a long standing doctrinal reliance on ICBMs for meeting the objectives for strategic nuclear forces. It is useful to change this assumption and to explore the consequences; One case of limited modernization is described below in the sensitivity analysis section.

3.1.2.3 Long Range Bombers

United States Figure 3-5 shows the bomber forces. In the absence of arms control the B-1B penetrator would be backfit to carry cruise missiles from 1991 on, so that by 1995 all B-1Bs would be ALCM equipped. The double

build down limits the number of ALCM carrying bombers, and this example assumes that the U.S. would deploy no fewer than 250 long range strategic bombers; 257 bombers are shown deployed in the year 2000, the majority of which are equipped for the penetrating mission. The largest bomber reductions take place after 1992, since the plateau of 5000 ballistic missile warheads has been reached. In this example it is during the 1992-1995 period that the bulk of both the heavy Soviet ICBM reduction and U.S. long range bomber reductions take place.

Soviet Union The Soviets retire Bison and Bear before the end of the decade, in favor of Backfire and Blackjack; by the year 2000 there are 125 Blackjack and 40 Backfire. To meet the 1992-1995 SWS build down the Soviets retire 110 Backfires, perhaps to tactical roles. One issue that might be addressed in negotiations is the possibility of distinguishing between long range bombers equipped to carry only conventional bombs from nuclear capable bombers of the same type, especially the Soviet Backfire and the American B-52. Such a determination cannot presently be made with national technical means, and verification would probably require on-site inspection. While ALCM capable bombers are distinguished from non-ALCM bombers by functionally related observable differences (FRODs), such FRODs have not been designed to distinguish between nuclear capable long range bombers and those capable of carrying only conventional bombs.

3.1.2.4 Conclusions from Build Down Worksheet

The double build down has two phases: the first, from 1984 to 1992, involves reductions in ballistic missile warheads to 5000 on either side. The second, from 1992 to 1995 requires cuts in bombers. In this example the Soviet Union defers its next ICBM modernization cycle until after the warhead build down is complete. This allows a greater proportion of the force to be maintained in ICBMs than if the SS-X-24 were deployed as soon and as quickly as American sources believe is now possible. Of course the Soviet Union could decide to invest more heavily in SLBMs, but this would come at the further expense of ICBMs. This example already assumes fairly heavy mixing in favor of increasing the proportion of the ballistic missile force on submarines.

One advantage of the double build down in comparison to the single build down is that it includes bombers, which the Soviet Union has long shown an interest in limiting, and which have occasionally been viewed by American sources as appropriate compensation for Soviet heavy missile reductions. The Soviets may not be interested in the trade as presented here if they believe one SS-18 to be more valuable in deterring U.S. aggression than one B-52 w/ALCM is to the U.S. for deterring Soviet aggression. In the Kent comprehensive double build down, one SS-18 equals one B-52 in standard weapon stations.

Finally, note that the number of Soviet long range bomber weapons is limited by double build down, thus reducing the requirements for continental air defenses in the event the United States should choose to deploy them.

3.1.3 Counterforce Exchange Model: Force Capabilities

3.1.3.1 Pre-Attack Static Indicators

Figure 3-6 shows differential trends in aggregate measures for the forces described in the previous sections. The United States loses some of the advantage it presently holds in the total number of weapons, while the Soviet Union loses much of its advantage in ballistic missile throwweight. The U.S. advantage in total weapons would shrink from 28.6% today to 9% by the year 2000, while the Soviet throwweight advantage would decrease from 3:1 to 1.5:1. Some analysts believe that this convergence alone indicates a more stable deterrent.

The United States reverses a Soviet advantage in EMT, but does not gain a significant advantage itself. The U.S. advantage in ECMP increases coincident with deployment of the MX (at 10 per year), the Midgetman, and the Trident II. In standard weapon stations neither side has an advantage, since the double build down prescribes equal starting points and compulsory straight line build downs in this metric.

3.1.3.2 Post First Strike

Figure 3-7 shows trends of effectiveness of the forces surviving to the United States after a Soviet first strike, and the forces remaining to the Soviet Union. United States aggregates are much lower than those for the Soviet Union, in advance of a retaliatory strike. There are several things worth noting:

- The U.S. has more total weapons surviving in the 1980s than the Soviet Union has remaining.
- The trends are tending monotonically downward for the Soviet Union after 1990, while the downward trend is reversed for the United States in later years, due primarily to the deployment of the Trident II.

3.1.3.3 Post Exchange

Figure 3-8 shows differential trends in aggregate measures after the counterforce exchange is completed, that is after the United States has retaliated against remaining Soviet ICBMs, all SLBM ports, and bomber bases. The result shows that as build down progresses, the United States is in an improving position to ride out a Soviet first strike and still have the advantage as measured by trends of aggregates. If the balance of residual force capability after a counterforce exchange is a criteria of prime importance, then pursuing double build down seems to be in the security interest of the United States.

3.1.3.4 Margins of Advantage

In considering forces remaining after a hypothetical exchange, the following question comes to mind: what residual amount of EMT, throwweight, or other measure, known to be available with high confidence to the United States after a counterforce exchange, would deter the Soviet Union from striking in the first place? Answers to this question have been disputed since the explosion of the first Soviet nuclear device. This paper examines

ratios of residual capability, with occasional reference to absolute magnitudes, to give some notion of the deterrent 'adequacy' of forces, and of deterrent stability. It is assumed that low residuals of EMT, SWS, and weapons, coupled with a large ratio of advantage for the opponent if he strikes first, indicate a less stable pre-attack balance than a situation in which only small advantages would result, with larger EMT/SWS residuals.

Figure 3-9 show that the United States gains an advantage in both EMT and SWS under the double build down even if the Soviet Union strikes first. The advantages begin to appear in 1988, and increase to a 50% margin in SWS, and a 100% margin in EMT by the year 2000. The United States has 1500 EMT remaining on 367 SNDVs in 1984, and almost 1900 EMT on 459 SNDVs in 2000. If the most important remaining purpose of these forces is the destruction of enemy population and industry, then these levels of EMT are well more than adequate. William Kaufmann estimates 400 EMT as sufficient to destroy the 200 largest cities in the Soviet Union. Something similar can be said of residual Soviet forces, which go from over 1700 EMT remaining on 887 SNDVs in 1984 to 965 EMT on 238 SNDVs in the year 2000.

3.1.3.5 Conclusions from Counterforce Exchange

The double build down, if it plays out as described above, is to the advantage of the United States. It puts the Soviet Union in a position of relative disadvantage should it strike first, and increases the vulnerability of Soviet forces without a similar increase in the vulnerability of U.S. forces, as described by trends in post-strike aggregate measures.

The case of a U.S. first strike further emphasizes this point. If the U.S. initiates an exchange, it ends up with a relative advantage, larger in all measures than in the aftermath of a Soviet first strike. This suggests that the Soviets, even knowing they would be placed at a net disadvantage by striking first, might do so to limit the magnitude of the disadvantage. From one point of view in strategic theory, the deterrent is most stable when each side ends up at a disadvantage by striking first. But this does not happen in the present case. Double build down does more to insure the relative vulnerability of Soviet forces to U.S. attack than it does to stabilize the deterrent. It should be no surprise that the result turns out this way; the concerns of force planners are often different from those of strategic theorists, and each does not have equal influence in the formulation of arms control proposals.

The following sections explore sensitivity of this result to several changes in assumption. While the increasing American advantage in both U.S. and Soviet first strike cases suggests increasing strategic instability, stability is a function not only of relative advantage in second and third strike forces, but of the gross number of weapons deployed before a strike. These are decreasing under build down.

3.1.4 Sensitivity Analysis of Force Capabilities

3.1.4.1 Limited Modernization

Several cases were run in which the scope of modernization was limited. A typical example is shown in Figures 3-10 to 3-15. Neither side deploys the next generation MIRVed ICBM, moving ahead with all other modernization

programs. The United States ends up with a higher proportion of its force in SLBMs, deploying 19 Trident IIs instead of 16, and relying on the Minuteman III (Mark 12A) for a MIRVed ICBM rather than the MX. The B-1B w/ALCM is deployed, and there are a total of 300 bombers instead of 256. The Soviet Union retains more of its SS-18 force, and deploys more of the SS-X-25 small missile. The submarine force is supplemented with more Delta IIIs, and the Yankees are retired over a longer period. The number of Soviet bombers is greater (250) than in the previous case (165) but the number of weapons is fewer because of greater reliance on the Backfire than on the Blackjack, of which there are 25 fewer in this example.

The pre-attack balance of deployed forces (Figure 3-13) shows a decrease in the convergence of numbers of weapons and ballistic missile throwweight when compared to the full modernization case.

The post-attack indices of capability (Figure 3-14) show the same trend toward increasing U.S. advantage. Figure 3-15 shows the U.S. retaining an advantage in residual SWS and EMT over time, although in both instances these advantages are smaller than in the full modernization case [note that the U.S. advantage in these plots is toward the top of the page, not toward the bottom, as for the previous case]. The United States has over 1500 EMT remaining on 367 SNDVs in 1984, and over 2700 EMT on 681 SNDVs in the year 2000.

3.1.4.2 Generated Alert

This case examines the effects of increasing the percentage of alert forces on both sides. Table 3-2 summarizes the changes. Both forces are now assumed to have 75% of their submarines at sea and 95% of their bombers on alert. The proportion of alert bombers surviving a first strike is reduced to account for the greater operational difficulty in flying the larger number of bombers out of danger. The full modernization double build down force structure is used for this calculation.

TABLE 3-2
GENERATED ALERT

percentages	DAY TO DAY ALERT		GENERATED ALERT
	U.S.	U.S.S.R.	BOTH
Subs at sea	.6	.4	.75
Bombers alert	.35	.1	.95
Alert bombers surviving in first strike	.95	.95	.85
Maximum bomber alert without strat warning	.8	.8	N/A

Figure 3-16 shows the EMT and SWS ratios of advantage for both a U.S. and Soviet first strike. The ratios of advantage are larger in favor of the United States than for the non-generated alert case, reflecting the effects of the larger U.S. bomber force. The average residual EMT is 60-70% higher than in the non-generated alert case for the United States, and is 35-45% higher for the Soviet Union.

3.1.4.3 Increase in Soviet Silo Hardness

This is an excursion on the generated alert case, to take account of the fact that many estimates of average Soviet silo hardness cite figures higher than 2000 psi. Using the generated alert assumptions from the previous section, this case adjusts the overall probabilities of kill of American missiles for an average Soviet silo hardness of 3500 psi. Figure 3-17 shows the result.

This is the first instance in which the United States is actually worse off by striking first than if the Soviet Union were to strike first, although the U.S. is better off after a counterforce exchange in terms of the ratio of advantage than it was before. (The U.S. is most assuredly worse off after a nuclear counterforce exchange than if it had never happened!) These ratios are significantly smaller than in the generated alert case with both sides having target hardnesses of 2000 psi. Notice that the scales are different.

3.1.4.4 Conclusions from Sensitivity Analysis

When changes are made in model assumptions to reflect a more 'realistic' pre-attack situation (generated alert, and higher average Soviet silo hardness) the United States still comes out on top in ratios of residual force capability, but is less inclined to strike first than in the previous scenario. The Soviet Union has little incentive to strike first because ^{it} knows this will only put the U.S. in a better position (in terms of post-strike aggregate measures) than previously, and the U.S. will be slower to strike first knowing that its relative post exchange advantage is diminished by doing so. This takes no account of 'non-rational' behavior among key political leaders, although such behavior may determine actions prior to a nuclear exchange.

Another interesting set of sensitivity analyses considers the effects of raising the 'price' for attacking land-based targets, as when the new small missiles are deployed in mobile rather than silo based mode. Results of these cases are incomplete, and are not presented here.

3.1.5 Summary of Double Build Down

The pros and cons associated with the double build down, suggested by the preceding analysis, are:

PROS

- United States second strike forces are adequate to fulfill countervalue missions even if the Soviet Union strikes first.
- Sensitivity analysis suggests that under double build down, with delayed MX deployment, neither side has an incentive to strike first because subsequent retaliation would leave the attacker at a disadvantage relative to the balance that would result if the opponent struck first (in terms of aggregate measures of force effectiveness). Coupled with real reductions in all three triad legs, this suggests greater stability of the nuclear deterrent.
- The United States advantage in weapons diminishes, as does the Soviet advantage in ballistic missile throw weight, with some positive effect on deterrent stability.
- Limits on destructive potential make it difficult to counter actions which enhance survivability of land based forces. This contributes to the uncertainties of successful attack, and enhances deterrent stability.

CONS

- Negotiation on the basis of throw weight is necessary for the double build down. Thus there is potential political difficulty for some members of Congress who have previously taken positions against throw weight limitation, but have supported the standard weapon station idea.
- It may be more difficult to get the Soviets to talk about the SWS, a new concept, than about warheads as the metric for reduction of the strategic forces.
- The START formula of nested sublimits can result in the same balance of forces as double build down, possibly with less resistance from top U.S. policy makers because of the simplicity of this approach relative to double build down.
- A negotiation over the proportionality constants which define the number of SWS per strategic launcher would likely not be advantageous for the United States.
- If present United States modernization schedules are met, double build down will result in unstable force structures, primarily because of the sharp reductions made necessary by deployment of the MX missile.

Most of the cons have to do with difficulties in negotiating the double build down, while the pros have to do with the implications for force capability and stability of the deterrent.

To elaborate on pro #4: the limits on destructive capability ensure that countermeasures cannot be taken against basing modes which enhance ICBM survivability without sacrificing coverage of some part of the target base. It usually 'costs' 2 SWS to get a .9 damage expectancy (DE) when attacking an MX in a hardened silo, but it would cost 6 SWS to attack the MX deployed in dispersed superhardened silos, 10 for MX in closely spaced superhardened silos, and 500-600 SWS per 1000 square miles to get a .9 DE against mobile launchers hardened to withstand 30 psi dynamic overpressure. The SWS build down, by limiting destructive capacity makes it difficult for the attacker to 'pay' enough to cover all land-based targets.

To elaborate on con #1 and #4, Figure 3-2 is helpful. If the Soviet Union were to commit itself to an increase in the ballistic missile K factor from 400, the SWS balance between the two forces would be upset. One SS-18 becomes worth a progressively smaller fraction of a B-52 bomber w/ALCM as the missile K factor increases from 400. This is due in part to the greater yield/weight ratio in the present U.S. missile force, or said another way, the more efficient use of throwweight by the U.S. In this plot bomber K factors are held constant, but a negotiation on these factors could also upset the trade of U.S. bombers for Soviet heavy missiles. Negotiation would have to resolve at least two points: the relative worth of a Soviet heavy missile vs. an ALCM equipped long range bomber, and limits on aggregate amounts of ballistic missile throwweight and gross take-off weight of bombers.

3.2 LIMITED SINGLE BUILD DOWN

3.2.1 Introduction

Figures 3-18 to 3-19 show the forces that might result under a single build down which requires annual cuts of five percent in ballistic missile warheads, or reduction based on build down ratios, whichever is greater. The ratios are 2:1 for ICBMs, 3:2 for SLBMs, and 1:1 for single warhead land-based missiles. These ratios make single warhead systems the most desirable to deploy, followed by SLBMs and MIRVed ICBMs; they are intended to provide incentives to move away from relatively vulnerable MIRVed ICBMs to less destabilizing systems.

3.2.2 Build Down Worksheet Results

3.2.2.1 Intercontinental Ballistic Missiles

United States Figure 3-18 shows an example of the evolution of ICBM forces on both sides under the single build down. In this scenario the United States has chosen to field an ICBM force which is eventually composed of 100 MX and 500 Midgetman missiles. The entire Minuteman force is retired by 1997. The number of warheads in each component of the force in any year is given by the vertical distance through the appropriately labeled area. For instance in 1990 there are 50 MX (500 warheads), 225 Minuteman III (675 Mark 12A warheads) and 150 Minuteman II single warhead missiles. This build down shows deployment of MX proceeding at a slower rate than would pertain in the event of unconstrained modernization. This analysis does not judge the political feasibility of the slow down, nor does it consider the implications of the resulting higher unit cost.

Target coverage planning is complicated by the removal from the force of the relatively high yield MM IIs, which have little countersilo capability, but are well suited to destroying soft area targets. The flexibility of the remaining force in rapid target reassignment and variable yields will be important considerations in modernization planning.

Soviet Union In this example the Soviet Union also moves toward a land-based force which is composed of large MIRVed ICBMs (the SS-X-24), and small mobile missiles (the SS-X-25). The build down has forced the Soviets to retire all of their third and fourth generation land-based missiles (SS-11,13,17,18,19) in order to deploy the SS-X series and to modernize the submarine force. Here, as for the United States, the price of modernization is deep cuts in existing systems. The deployment for the SS-X-24 is slowed under build down, as was the MX deployment.

3.2.2.2 Submarine Launched Ballistic Missiles

United States The United States submarine launched ballistic missile fleet (Figure 3-19) evolves into a force of 18 Trident submarines armed with D5 missiles. Total SLBM warheads decrease by about 1800 over the period. The countersilo capability of the force increases by a factor of 6-10, as measured in equivalent countermilitary potential

There is some mixing between ICBM and SLBM forces after 1992 (by which time the build down has run its course), with SLBM reductions taking place to

pay for Midgetman deployment. This mixing is an important factor in being able to deploy the 500 Midgetman missiles. In the late 1980s and early 1990s the number of ICBM launchers decreases to less than 400 from the present 1034. After the full Midgetman procurement the number of land-based launchers increases to over 600.

Although exchange ratios are potentially misleading, it is worth noting that they show deteriorating conditions for stability in this example, from both the American and Soviet points of view. The Soviet ratio goes from 4.7 in 1984 to 8.0 in 1991 and 4.0 by 2000; the Americans ratio goes from 1.2 in 1984 to 3.5 in 1991 and 4.5 in 2000.

Soviet Union The only class of strategic nuclear submarine which the Soviets retire completely is the Yankee. There is however a substantial change in overall force structure, from 24.4% of Soviet ballistic missiles being on submarines in 1984 to 53% by the year 2000. If the Soviet Union wants to both modernize ICBMs and expand and modernize the SLBM force, build down dictates substantial ICBM warhead reductions. The degree of mixing ICBMs for SLBMs is heavy, especially from 1984 to 1991, when additions are made to the Typhoon fleet.

3.2.2.3 United States and Soviet Bombers

The limited single build down does not include bombers. Yet for purposes of relative force capability calculations it was necessary to postulate bomber forces for the two sides. The number of bombers and bomber weapons is consistent with the latest U.S. START proposal (see page 1-3), which actually does little to limit bomber assets on the two sides in comparison to the double build down. The Administration has proposed a concurrent build down of strategic bombers, but the specifics of this proposal were not included in the October 1983 package.

3.2.2.4 Conclusions from Build Down Worksheet

This choice of force composition is representative of what the two sides might do to satisfy the terms of the 5% / 2:1, 3:2, 1:1 build down in the absence of a simultaneous build down of destructive potential. Many cases were run which allowed for the full range of modernization programs on each side, and some general observations can be made.

In the present case, the ratio rule constrains American force planning choices only in the final year of the eight that the build down is in force. In the previous seven years the 5% minimum reduction rule requires greater cuts than the ratio rule. This is typical of the effect of the single build down on American forces: it is possible to deploy the full range of modern systems, albeit with delays and some reduction in numbers, yet not feel the incentives implied in the ratios.

Figure 3-10 depicts changes in ballistic missile accounting warheads for U.S. forces in the single build down example. The top half shows the changes in accounting warheads separately for ICBMs and SLBMs. The degree of mixing is indicated by the comparative lengths of the bars. The pattern of force modernization is such that neither sea nor land-based forces are systematically cut in the interest of modernizing the other. The Navy and Air Force 'pay' for their modernization programs with reductions of strategic

systems under their respective jurisdictions.

From 1992 on, although there are increases in accounting warheads, there is no increase in real warheads; once the 5000 plateau is reached, new warheads can be exchanged one for one with old warheads, so there is no further penalty for modernization. It is in the years after the build down has run out that the Midgetman deployment and Trident D5 backfit take place, and some degree of mixing takes place in favor of Midgetman deployment. The percentage of U.S. warheads on SSBNs remains approximately the same.

For the Soviet Union, the ratio rule is constraining for seven of the ten years the build down is in force. This contrast with the American situation is due to the timing of modernization: SS-X-24, SS-X-25, and Typhoon deployment all begin in the build down period, whereas Midgetman deployment does not commence until 1992, when the 5000 warhead ceiling has already been reached by the United States. The timing of modernization determines which of the build down reduction rules is constraining, but for neither side does the ratio build down preclude significant modernization of land-based MIRVed ICBMs.

3.2.3 Counterforce Exchange Model

3.2.3.1 Margins of Advantage.

Figures 3-21 and 3-22 show the post-exchange ratios of advantage for the single build down for both Soviet and American first strikes, in standard weapon stations and equivalent megatons. The Soviet Union is never able to change the SWS ratio in its favor by striking first. The Soviets lose the capacity to change the EMT ratio in their favor by a first strike very early in the build down. The United States is able to increase its margin of advantage by striking first, but is well able to ride out a first strike without being put at a relative disadvantage.

If the Soviets strike first (in the year 2000), the United States has surviving after the exchange 335 MIRVed SLBMs and 60 bombers, over 2500 EMT in over 4000 SWS. If the U.S. strikes first, the Soviet Union has surviving after the exchange over 100 MIRVed SLBMs, over 400 EMT in over 700 SWS. In both cases the victim of the first strike is left after the exchange with enough weapons to destroy many of the opponent's large cities. It is impossible to argue conclusively that either side would 'benefit' by striking first. Nonetheless, the forces resulting from single build down are judged to result in a less stable pre-attack balance than those in the double build down case, because the United States could achieve larger post-attack ratios of advantage. This statement is made by comparing ratios of advantage for the single build down which are equivalent to those in Figure 3-17 for the double build down -- the generated alert situation, with Soviet silos of average hardness 3500 psi.

3.2.3.2 Conclusions from Counterforce Exchange

The exemplary single build down does not result in force postures which diminish the first strike incentive as much as those resulting from the exemplary double build down. This is primarily because bombers are excluded from the single build down, and are instead limited by the START proposal to less than 400 bombers and less than 3500 ALCM; these terms are less

restrictive of U.S. bomber deployment than the exemplary double build down. If bombers are included in the single build down, the trends in relative capability are still toward American advantage, but the situation discussed in connection with the double build down is repeated, (see section 3.1.4.2) in which the U.S. would diminish its advantage by striking first. The convergence of forces in terms of weapons and throwweight is also replicated.

The implications for stability of this case of single build down are thus worse than for the exemplary double build down. The United States always has an incentive to strike first to increase its margin of advantage. The U.S. also increases its pre-attack advantage in the number of weapons, while the Soviet advantage in ballistic missile throwweight is diminished, though not to the same extent as in the exemplary double build down.

3.2.4 Summary of Single Build Down

The pros and cons to the single build down which are suggested by this analysis include:

PROS

- The incentive effect of the build down ratios is intuitively appealing and simple, and thus in the spirit of the Scowcroft Commission call for arms control proposals.
- The 5 percent annual reduction requirement ensures that when modernization induced reductions would be small, a larger number of warheads must be cut.
- The single build down results in significant reductions in the number of ballistic missile warheads on both sides, and a decrease in the aggregate levels of weapons.
- The single build down has significant support in the Congress, having been conceived and refined there during 1983. The concepts of modernization induced reduction and incentives in favor of stabilizing systems are politically attractive.

CONS

- The ratio build down is rarely constraining, thus diminishing the incentive effects intended in the original proposal.
- The limited single build down does not include bombers, which could complicate the negotiation of compensating reductions of Soviet heavy missiles for U.S. bomber cuts.
- The number of bombers allowed under exemplary single build down results in an increase in the pre-attack U.S. advantage in numbers of weapons, while the Soviet ballistic missile throw weight margin is diminished. (Pro for U.S. capability, con for negotiability)
- If present U.S. modernization schedules are met, single build down will result in a less stable balance of forces than if unconstrained modernization were to take place. This is due to accelerated retirement of U.S. ICBMs before a sea based counterforce capability is introduced.

If the single build down were made comprehensive, it would be more attractive than the present formulation, which excludes bombers. The ratio rule could be made to operate more frequently by raising the warhead plateau, lowering the annual percentage minimum reduction, increasing the build down ratios, or some combination of these. Over the course of a negotiation which has the ratios, ceiling and percentage minimum as points of discussion, the incentive effects might once again become important. But if the reduction requirements are made less stringent, the convergence of aggregate numbers of weapons and ballistic missile throw weight, desirable for stability reasons, will be diminished.

SECTION FOUR RECOMMENDATION

Build down is worth keeping as part of the U.S. negotiating position so long as it can be tailored to reconcile, as far as possible, significant reductions in the number of deployed nuclear weapons and MX deployment, with a more stable nuclear deterrent. This is best accomplished by a reduced rate of MX deployment (10 per year) from that presently planned, with a double build down in force. On the basis of this analysis, the build down should continue to be part of the U.S. START negotiating position.

The double and single build downs have advantages and disadvantage noted in sections 3.1.5 and 3.2.4. On balance the double build down is preferred, because it is comprehensive, and the prospects that it will result in a more stable deterrent are better. In order to capture the full value of the double build down limit on destructive potential, there should be nothing to prohibit basing modes which enhance survivability of ICBM's in a draft treaty. Because it is largely irrelevant in the context of the other constraining elements of the build down, the variable ratios should be removed as an element of the current proposal, unless bombers are included, and the warhead plateau, percentage minimum, and ratios are changed so that the ratio rule is made to have some effect on force planning. The symbolic value of the ratio build down is great, but its continued inclusion is not consonant with the need to present a coherent arms control proposal to the Soviet Union. To summarize:

- Retain build down as an element of the U.S. START negotiating position.
- Pursue the double build down, using explicit limits on throw weight as a point of negotiation rather than the proportionality constants which define the standard weapon station.
- Remove the variable ratio rule as an element of the proposal, unless it is changed to include bomber weapons.
- Continue to press for immediate ceilings on ballistic missile warheads and standard weapon stations, and guaranteed annual build downs of both.
- Do not present proposals which prohibit or discourage basing modes which might enhance survivability of ICBM's

TABLE 1-1

Summary Chronology of Congressional Build Down Proposals

SENATE RESOLUTION 57 3 February 1983

- o 2:1 ratio for new destabilizing systems
- o net reduction in total number of warheads
- o freedom to mix
- o SALT II counting rules and implementation procedures
- o agreed verification measures
- o important to maintain tactical weapons talks as distinct

"IMPACT OF BUILD DOWN" Cohen 22 June 1983

- o flexibility in ratios, 2:1 basic, perhaps 3:1 MIRVed ICBM's, 3:2 SICBM
- o applied comprehensively
- o freedom to mix (ballistic missiles v. air breathing systems)
- o concurrent plateaus
- o SALT verification procedures
- o SALT counting rules, supplemented for bombers
- o agreed data base
- o 5000 warheads plus allowance for other strategic launchers
- o complement to START, quickly negotiable

NUNN, COHEN, PERCY LETTER TO SCOWCROFT 9 September 1983

- o ceiling on number of warheads
- o ceiling on destructive capacity
- o guaranteed annual build down in ballistic missile warheads
- o create incentives favoring stabilizing systems
- o second annual guaranteed build down of
 - overall destructive capability (to include bombers)
- o not to prohibit or discourage measures to enhance stability
- o seek immediately as precursor to START
- o first build down uses percentage minimum
- o second build down by steadily declining limit
- o start from positions of rough equality
- o a Vladivostok type of agreement

TYPES OF BUILD DOWN CONSIDERED

COUNTING METRIC	REDUCTION RULE	SYSTEMS INCLUDED	TARGET CEILING
WARHEADS ONLY	VARIABLE RATIOS 5% MINIMUM REDUCTION	ICBM SLBM	5000 WARHEADS
WARHEADS & STANDARD WEAPON STATIONS	DOUBLE STRAIGHT LINE	ICBM SLBM BOMBERS	5000 WARHEADS 8500 SWS

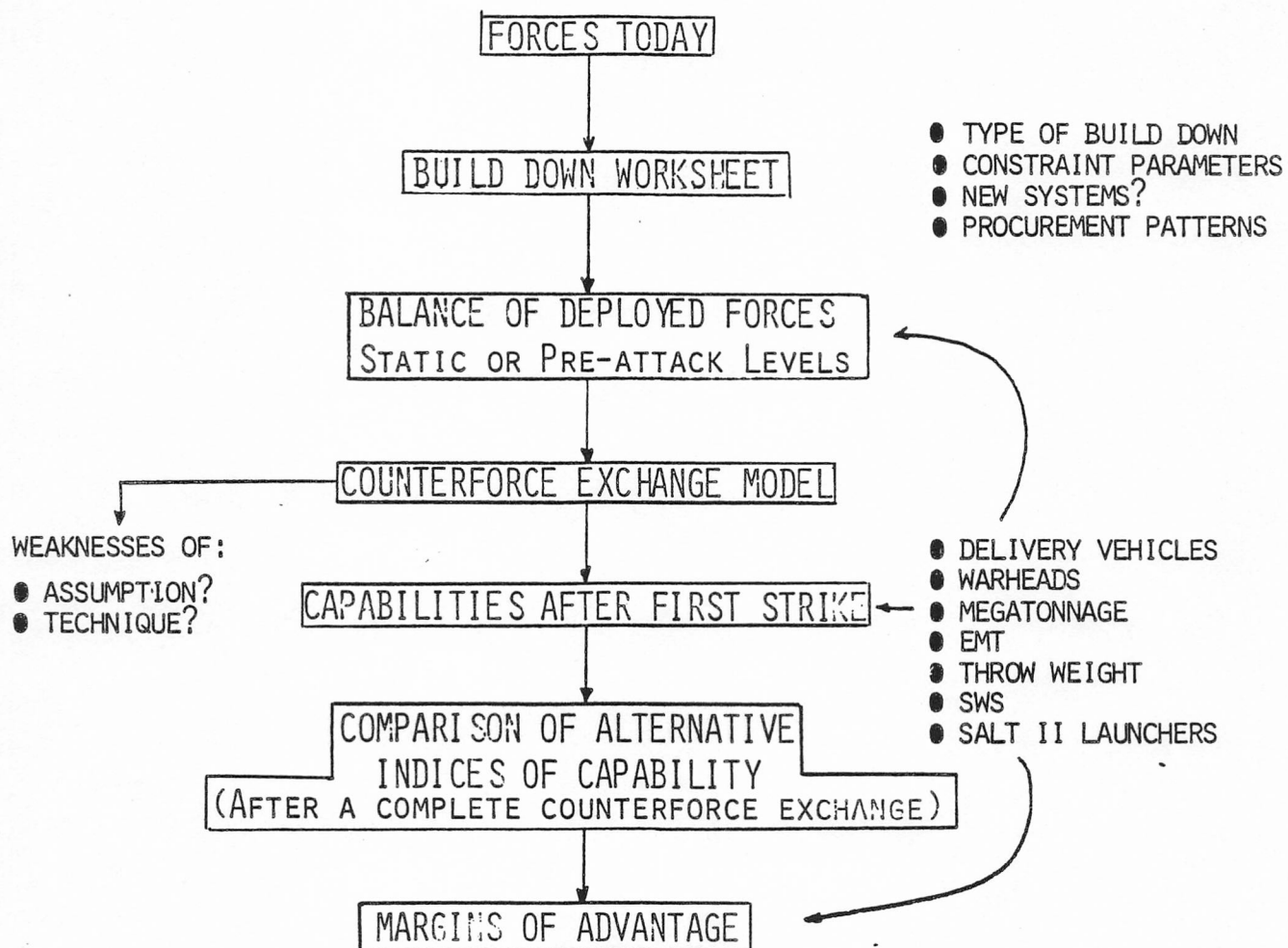
LIMITED SINGLE
BUILD DOWN
PRESIDENT'S
OCT 4 PLAN

COMPREHENSIVE
DOUBLE BUILD
DOWN
KENT PROPOSAL

FIGURE 2-1

FIGURE 2-2

METHODOLOGY



Subjective Decision Rules for Build Down Exercise

[]	*****[]
[]	[]
[]	Before beginning []
[]	----- []
[]	o single, double? []
[]	o comprehensive? []
[]	o percentage minimum, straight line, no minimum? []
[]	o ratios? []
[]	o Double build down throw weight divisors? []
[]	o mix or not? []
[]	o counting rules, data base? []
[]	o ceilings, target years? []
[]	o maximum rates of procurement, retirement? []
[]	[]
[]	While building down []
[]	----- []
[]	o degree of mix, heavy or light? []
[]	o which new systems to buy? []
[]	o number of each system desired at FOC []
[]	o rates of procurement and retirement []
[]	o program priorities []
[]	----- []

TABLE 2-1

TABLE 2-2

A List of Possible Build Down Constraints

[]	*****[]
[]	[]
[]	WARHEADS * DESTRUCTIVE CAPABILITY []
[]	----- []
[]	[]
[]	WARHEAD :% MINIMUM * K FACTORS FOR OTHER []
[]	CEILING REDUCTION * STANDARD WEAPON STATIONS MEASURE? []
[]	----- []
[]	[]
[]	RATIOS * Missiles Bombers []
[]	ICBM SLBM SICBM * []
[]	for for for for for * single []
[]	example example example example example * warhead MIRVed w/ALCM non []
[]	5000 5%/year 2:1 3:2 1:1 * for for for for []
[]	example example example example example * example example example example []
[]	500 400 25,000 50,000 []
[]	 []
[]	*****[]

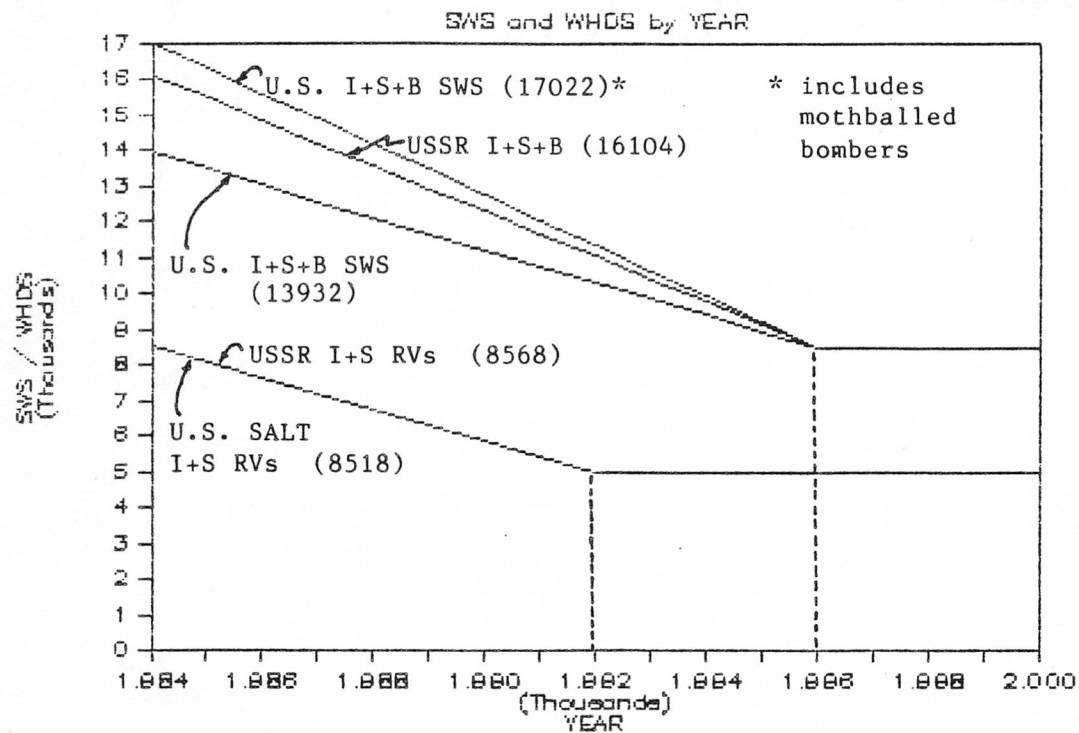
FIGURE 2-3

SINGLE BUILD DOWN WORKSHEET EXAMPLE

SYSTEM	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	WGTS	WHDS
IN	34	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
MM II	450	360	270	270	270	200	150	100	100	50	50	0	0	0	0	0	0	1	1
MM Mk 12	250	230	195	95	10	0	0	0	0	0	0	0	0	0	0	0	0	3	3
MM Mk12Ai	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	6	3
MM Mk12Ao	0	0	0	0	0	-58	-75	-140	-187	-209	-250	-280	-292	-300	-300	-300	-300	3	3
MX in	0	0	10	20	30	40	50	60	70	80	90	100	100	100	100	100	100	20	10
MX out	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	10
MIDGET in	0	0	0	0	0	0	0	0	20	100	200	300	400	500	500	500	500	1	1
MIDGETout	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
POLA3	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	48	48
POSC3	19	16	12	10	9	7	4	2	0	0	0	0	0	0	0	0	0	160	160
POSC4	12	12	12	12	12	12	12	12	12	10	8	6	4	2	0	0	0	128	128
TRIC4 in	3	5	7	8	8	8	8	8	8	8	8	8	8	8	8	8	8	288	192
TRIC4 out	0	0	0	0	0	0	0	0	0	-1	-2	-3	-4	-5	-6	-7	-8	192	192
TRID5 in	0	0	0	0	0	1	2	3	4	6	8	10	12	14	16	17	18	288	192
TRID5 out	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	192	192
deltas																			
TITAN	-34	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MM II	-90	-90	0	0	-70	-50	-50	0	-50	0	-50	0	0	0	0	0	0	0	0
MM Mk 12	-60	-105	-300	-255	-30	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MM Mk12Ai	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MM Mk12Ao	0	0	0	0	-174	-51	-195	-141	-66	-123	-90	-36	-24	0	0	0	0	0	0
MX in	0	200	200	200	200	200	200	200	200	200	200	200	0	0	0	0	0	0	0
MX out	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MIDGET in	0	0	0	0	0	0	0	0	20	80	100	100	100	100	0	0	0	0	0
MIDGETout	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
POLA3	-96	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
POSC3	-480	-640	-320	-160	-320	-480	-320	-320	0	0	0	0	0	0	0	0	0	0	0
POSC4	0	0	0	0	0	0	0	0	-256	-256	-256	-256	-256	-256	-256	0	0	0	0
TRIC4 in	576	576	288	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TRIC4 out	0	0	0	0	0	0	0	0	-192	-192	-192	-192	-192	-192	-192	-192	-192	0	0
TRID5 in	0	0	0	0	288	288	288	288	576	576	576	576	576	576	576	288	288	0	0
TRID5 out	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
acct whds																			
ICBM	-184	5	-100	-55	-74	99	-45	79	164	177	160	64	76	0	0	0	0	0	0
SLBM	0	-64	-32	-160	-32	-192	-32	-32	128	128	128	128	128	128	128	96	96	0	0
TOTAL	-184	-59	-132	-215	-106	-93	-77	47	292	305	288	192	204	128	96	96	0	0	0
ACCUM DEL	-184	-243	-375	-590	-696	-789	-866	-819	-527	-222	66	258	462	590	686	782	0	0	0
whds																			
ICBM 2134	1950	1855	1655	1500	1326	1325	1180	1159	1223	1300	1360	1424	1500	1500	1500	1500	1500	0	0
	-184	-95	-200	-155	-174	-1	-145	-21	64	77	60	64	76	0	0	0	0	0	0
SLBM 5248	5056	4800	4672	4512	4384	4096	3968	3840	3776	3712	3648	3584	3520	3456	3456	3456	3456	0	0
	-192	-256	-128	-160	-128	-288	-128	-128	-64	-64	-64	-64	-64	-64	-64	-64	-64	0	0
TOTAL 7382	7006	6655	6327	6012	5710	5421	5148	4999	4999	5012	5008	5008	5020	4956	4956	4956	4956	0	0
	-376	-351	-328	-315	-302	-289	-273	-149	0	13	-4	0	12	-64	0	0	0	0	0
PERCENT	-5.09	-5.01	-4.93	-4.98	-5.02	-5.06	-5.04	-2.89	0	.2601	-.080	0	.2396	-1.27	0	0	0	0	0
M DEL	-376	-727	-1055	-1370	-1672	-1961	-2234	-2383	-2383	-2370	-2374	-2374	-2362	-2426	-2426	-2426	-2426	0	0

KENT DOUBLE BUILD DOWN PROPOSAL

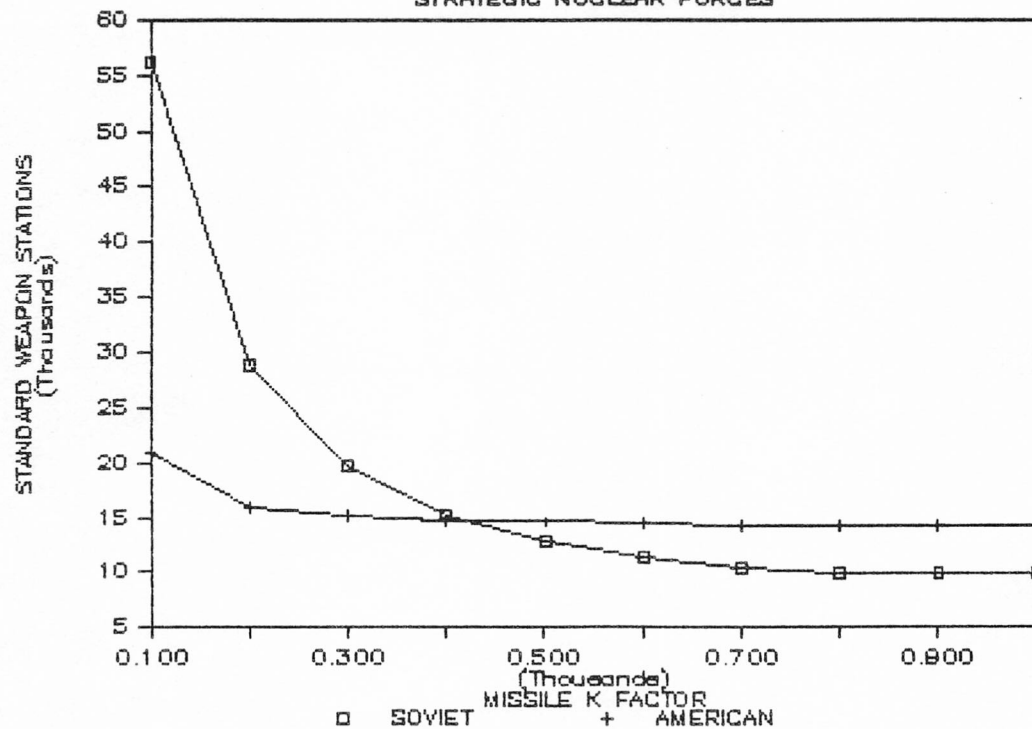
FIGURE 3-1



STD WEAPON STATIONS by K FACTOR

STRATEGIC NUCLEAR FORCES

FIGURE 3-2



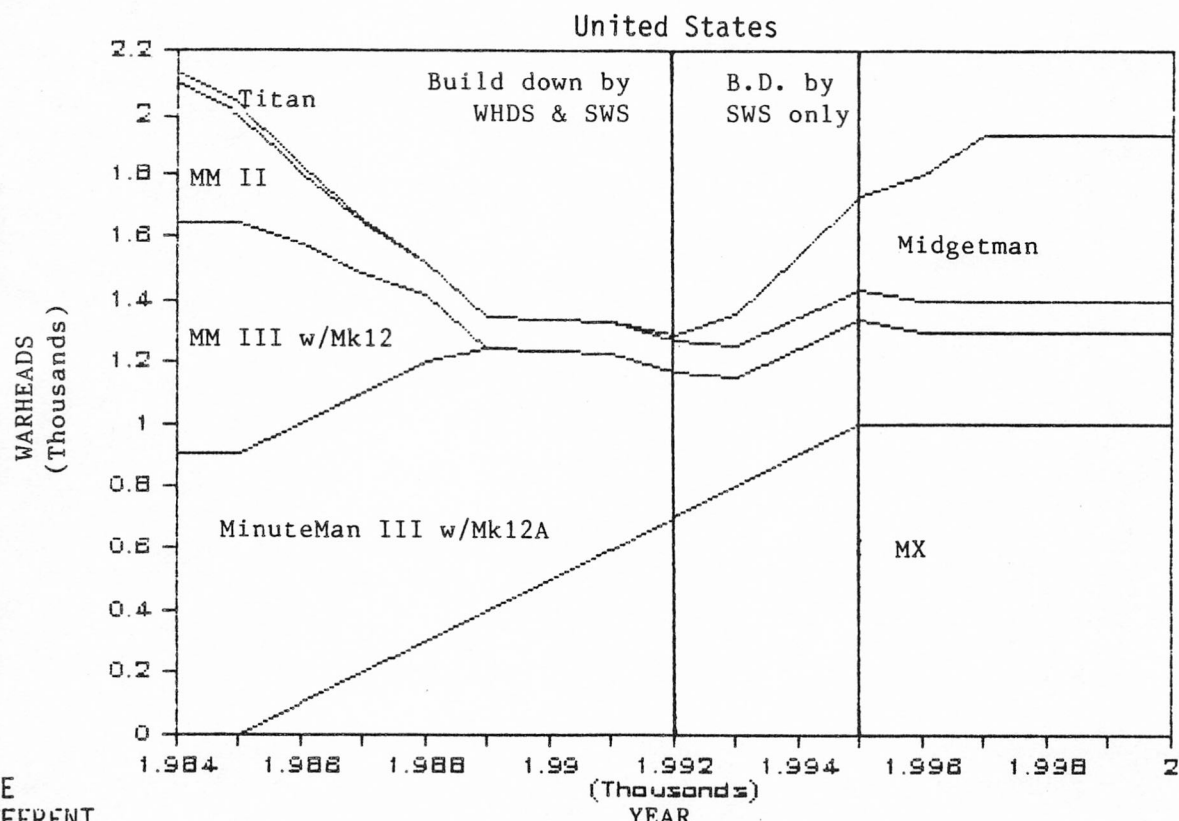
STANDARD WEAPON WORKSHEET
AMERICAN FORCES

TABLE 3-1

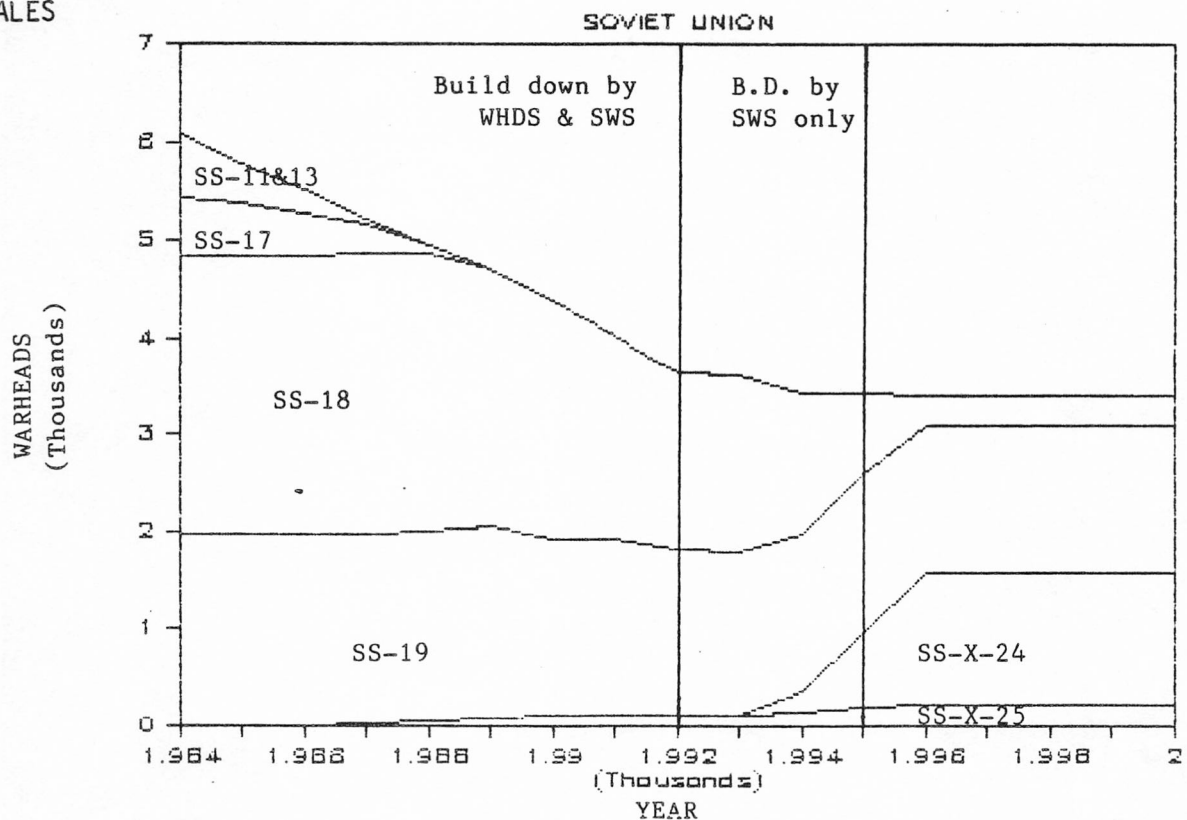
SYSTEM:	DECLARED MAXIMUM NUMBER TESTED		THRWGHT or TGW (Kkg)	MISSILES				BOMBERS		SWS/ launcher	SWS/ SNDV	BREAK- OVER K FACTOR
				MIRV	SINGLE	SOLID	LIQUID	non ALCM	ALCM			
				THRWGHT/ 400	THRWGHT/ 500	VOLUME/ 400	VOLUME/ 400	TGW/ 50000	TGW/ 25000			
TITAN II	1	1	3.75		7.5	N/A	N/A			7.5	7.5	3750
MM II	1	1	.737		1.474	N/A	N/A			1.474	1.474	737
MM III	3	7	.899	2.2475		N/A	N/A			7	7	128.4286
										7	7	
										7	7	
MX	10	10	3.58	8.95		N/A	N/A			10	10	358
										10	10	
MIDGET	1	1	.453		.906	N/A	N/A			1	1	453
										1	1	
POL A3	3	3	.453	1.1325		N/A	N/A			3	48	151
POSC C3	10	14	1.5	3.75		N/A	N/A			14	224	187.1429
POSC C4	8	8	1.31	3.275		N/A	N/A			8	128	163.75
TRID C4	8	8	1.31	3.275		N/A	N/A			8	128	163.75
										8	192	
TRID D5	8	8	2.3	5.75		N/A	N/A			8	192	287.5
										8	192	
FB-111	4	4	115 Klbs					2.3		4	4	
B-52 w/o	8	8	480 Klbs					9.76		9.76	9.76	
										9.76	9.76	
B-52 ALCM	20	20	480 Klbs						19.52	20	20	
										20	20	
B-1B w/o	16	16	500 Klbs					10		16	16	
										16	16	
B-1B ALCM	22	22	500 Klbs						20	22	22	
STEALTH	5	5	250 Klbs					5		5	5	

SYSTEM:	DECLARED MAXIMUM NUMBER TESTED		THRWGHT or TGW (Kkg)	MISSILES				BOMBERS		SWS/ launcher	SWS/ SNDV	BREAK- OVER K FACTOR
				MIRV	SINGLE	SOLID	LIQUID	non ALCM	ALCM			
				THRWGHT/ 400	THRWGHT/ 500	VOLUME/ 400	VOLUME/ 400	TGW/ 50000	TGW/ 25000			
SS-11	1	1	.998		1.996	N/A	N/A			1.996	1.996	998
SS-13	1	1	.68		1.36	N/A	N/A			1.36	1.36	680
SS-17	4	4	2.73	6.825		N/A	N/A			6.825	6.825	682.5
SS-18	10	10	7.48	18.7		N/A	N/A			18.7	18.7	748
										18.7	18.7	
										18.7	18.7	
SS-19	6	6	3.41	8.525		N/A	N/A			8.525	8.525	568.3333
										8.525	8.525	
SS-X-24	10	10	3.63	9.075		N/A	N/A			10	10	363
PL-5	1	1	1.36		2.72	N/A	N/A			2.72	2.72	1360
YANK(N-6)	1	1	.725		1.45	N/A	N/A			1.45	23.2	725
DI(N-8)	1	1	.816		1.632	N/A	N/A			1.632	19.584	816
DII(N-8)	1	1	.816		1.632	N/A	N/A			1.632	26.112	816
DIII(N-10)	3	3	1.13	2.825		N/A	N/A			3	48	376.6667
										3	48	
TYP(N-20)	9	9	3.4	8.5		N/A	N/A			9	180	377.7778
BEAR	2	2	414.5 Klbs					8.29		8.29	8.29	
BISON	1	1	350 Klbs					7		7	7	
BACKFIRE	1	1	277 Klbs					5.54		5.54	5.54	
BLACKJACK	10	10	400 Klbs						16	16	16	

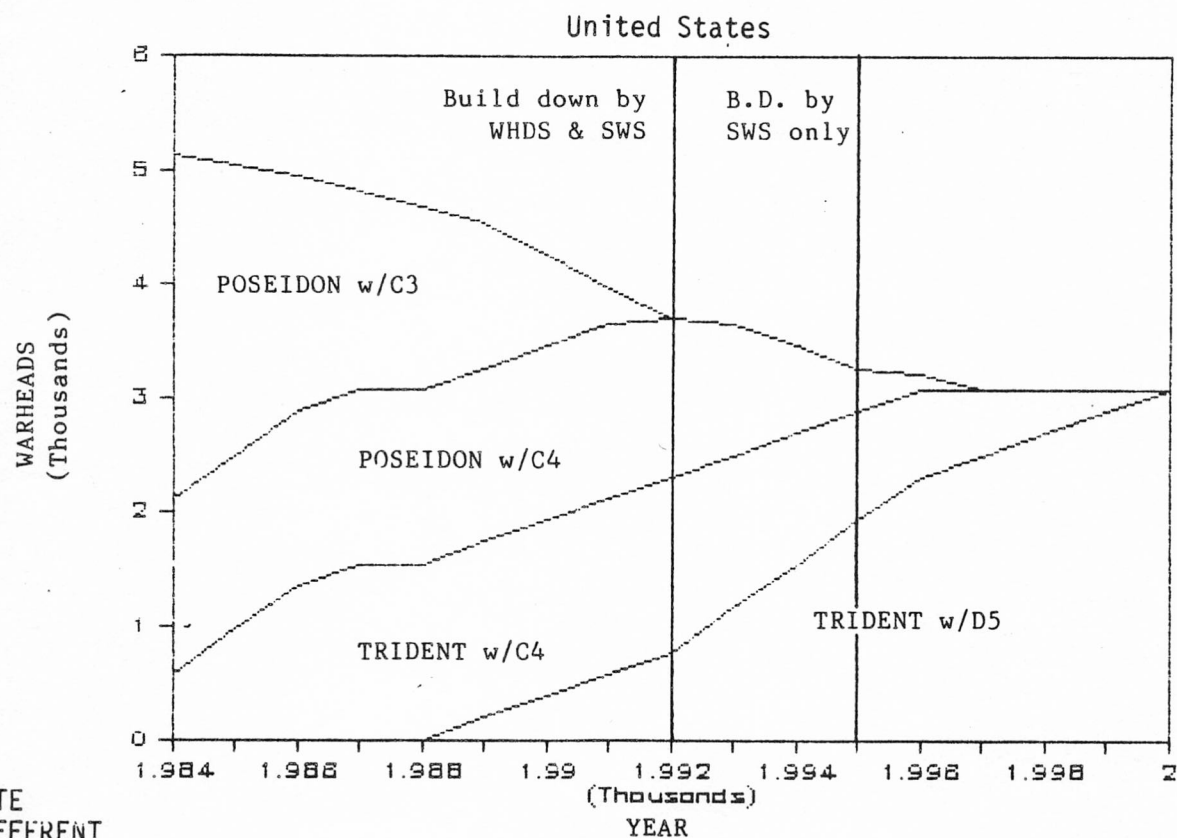
EXEMPLARY ICBM FORCE COMPOSITIONS UNDER DOUBLE BUILD DOWN



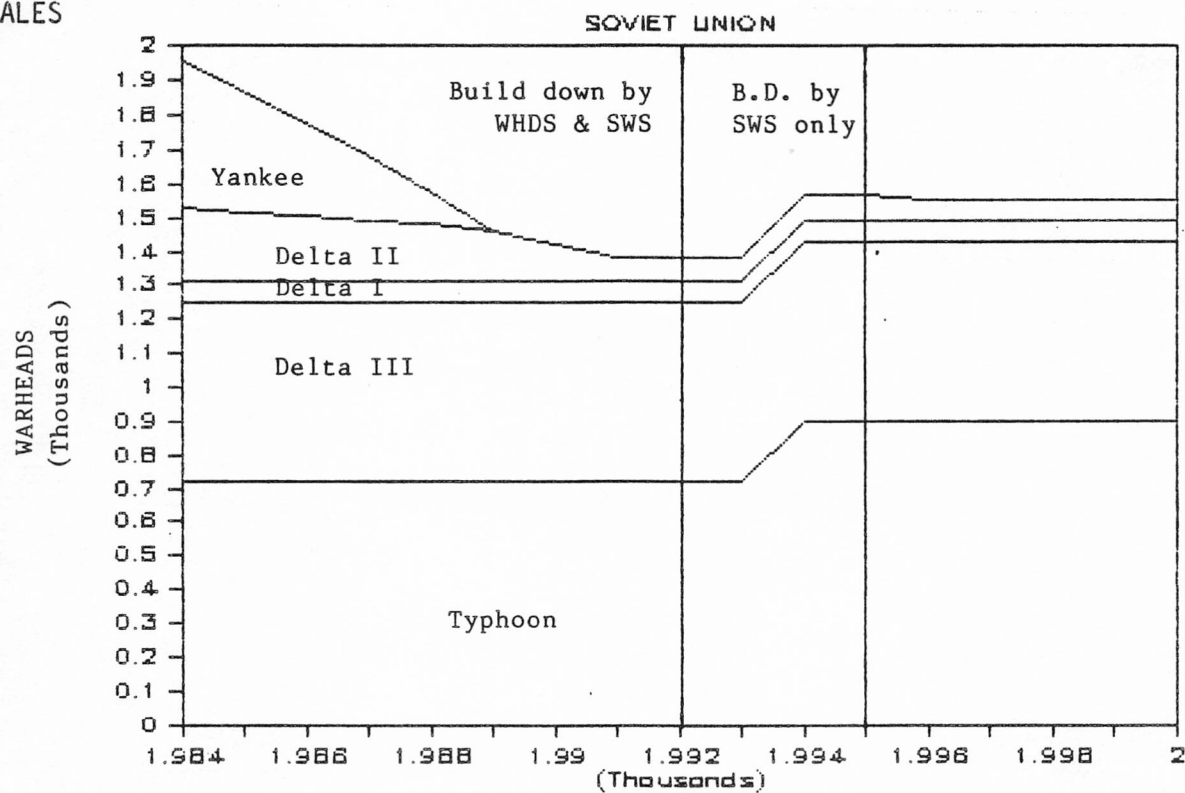
NOTE
DIFFERENT
SCALES



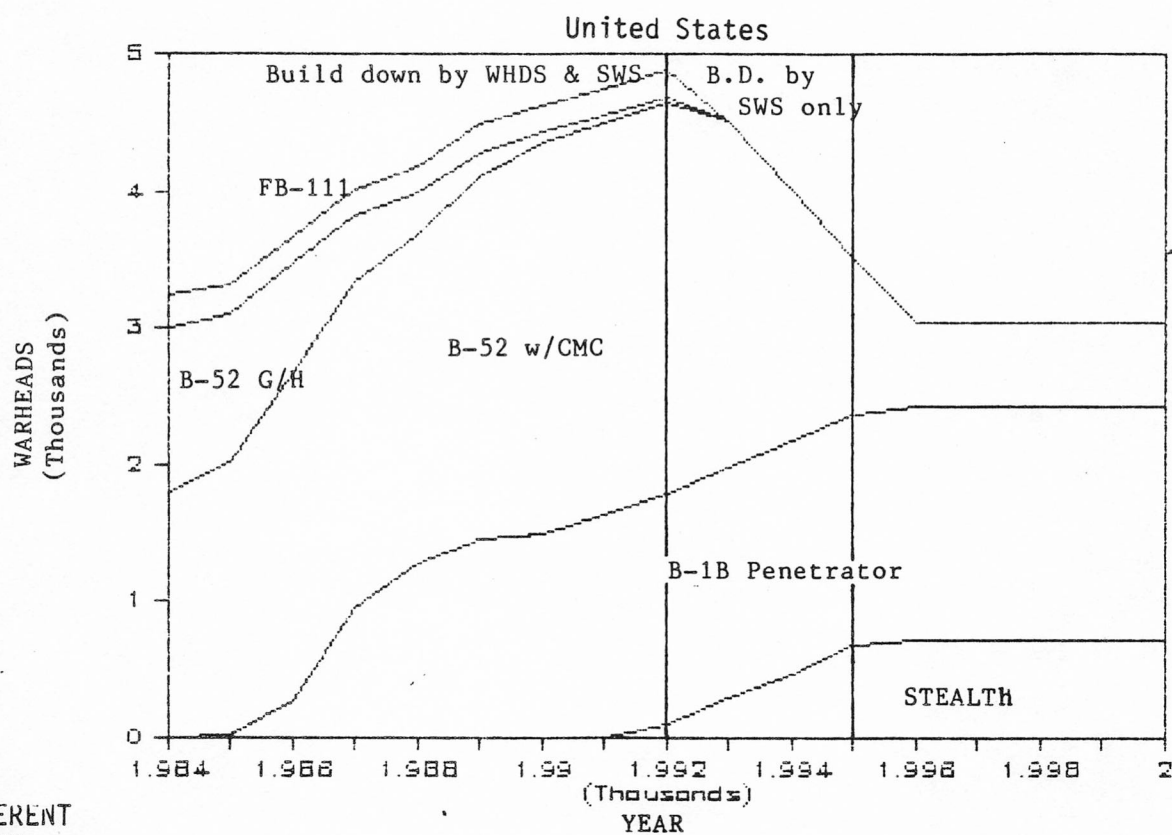
EXEMPLARY SLBM FORCE COMPOSITIONS UNDER DOUBLE BUILD DOWN



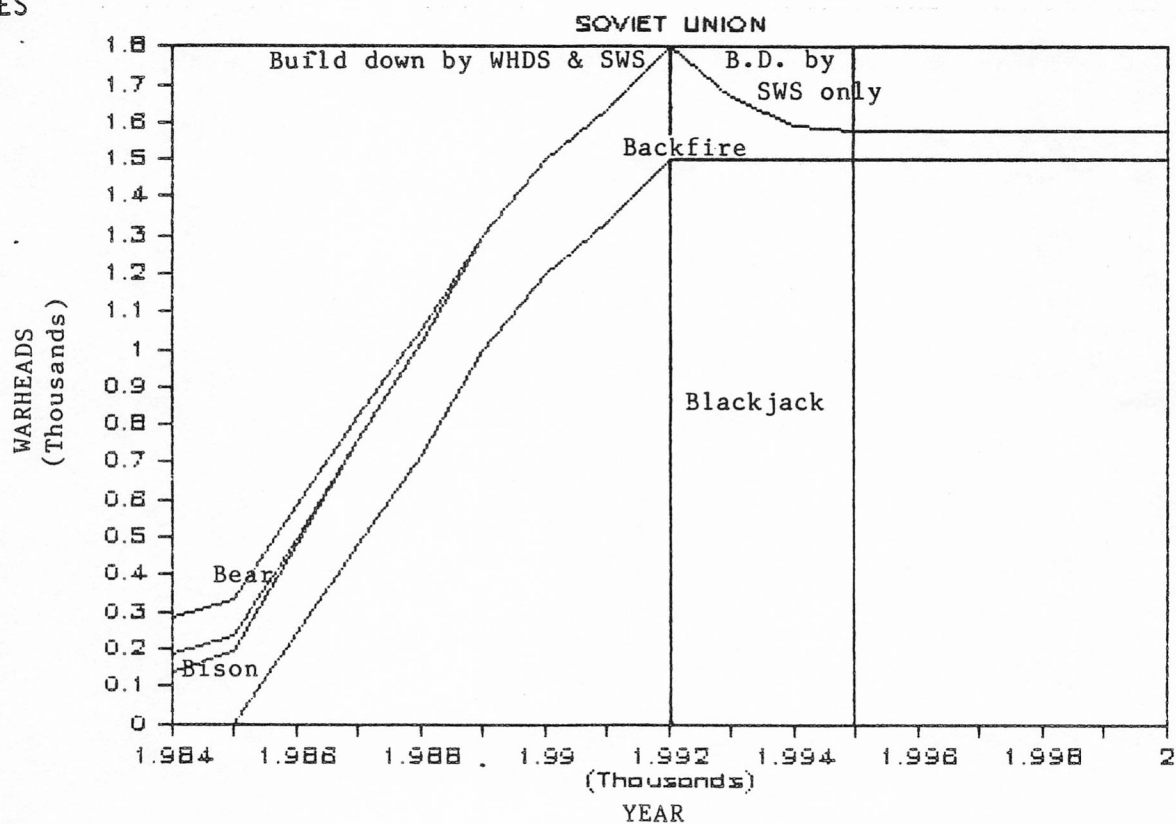
NOTE
DIFFERENT
SCALES

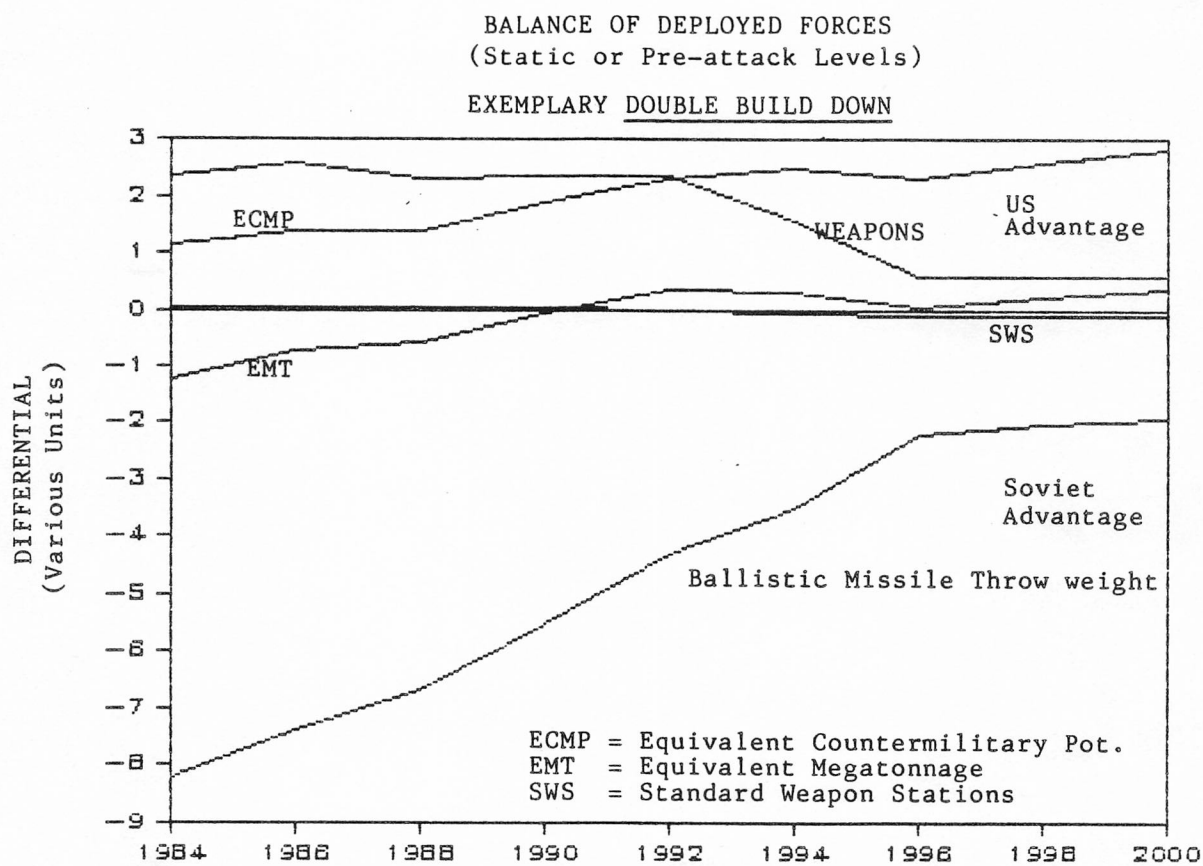


EXEMPLARY BOMBER FORCE COMPOSITIONS UNDER DOUBLE BUILD DOWN



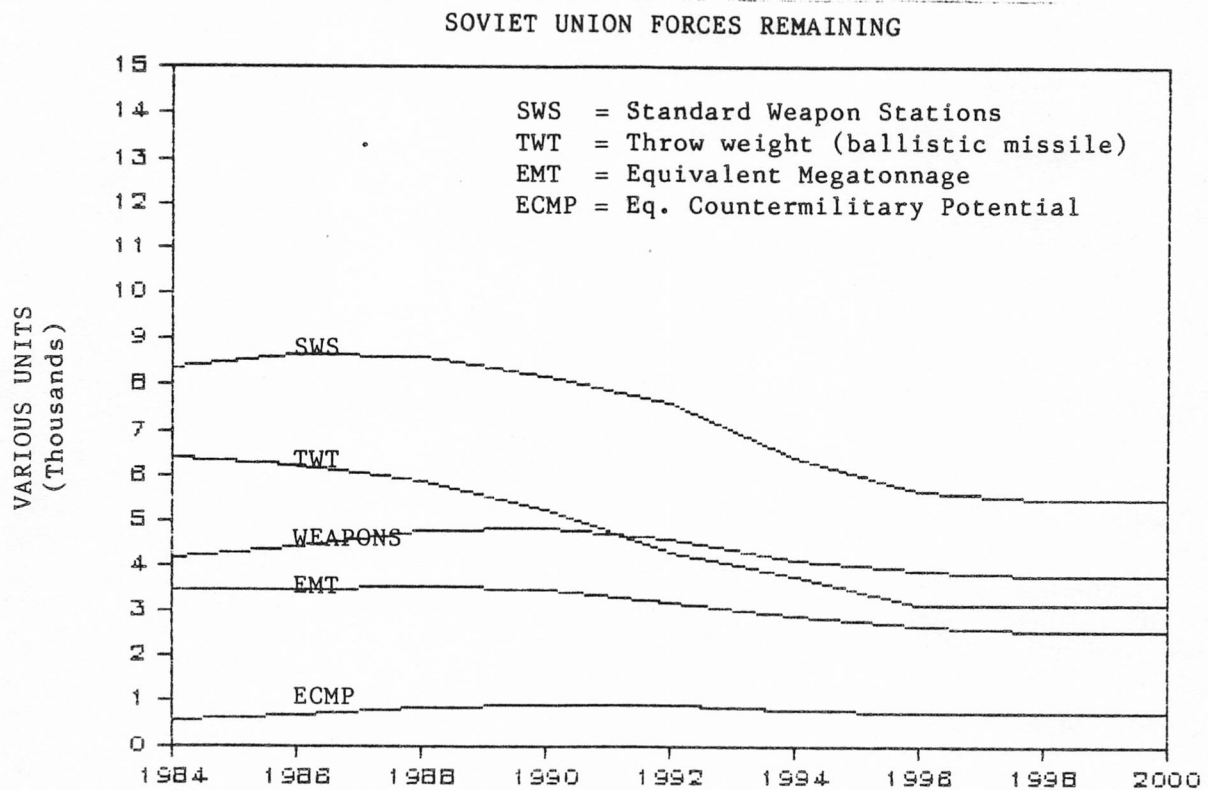
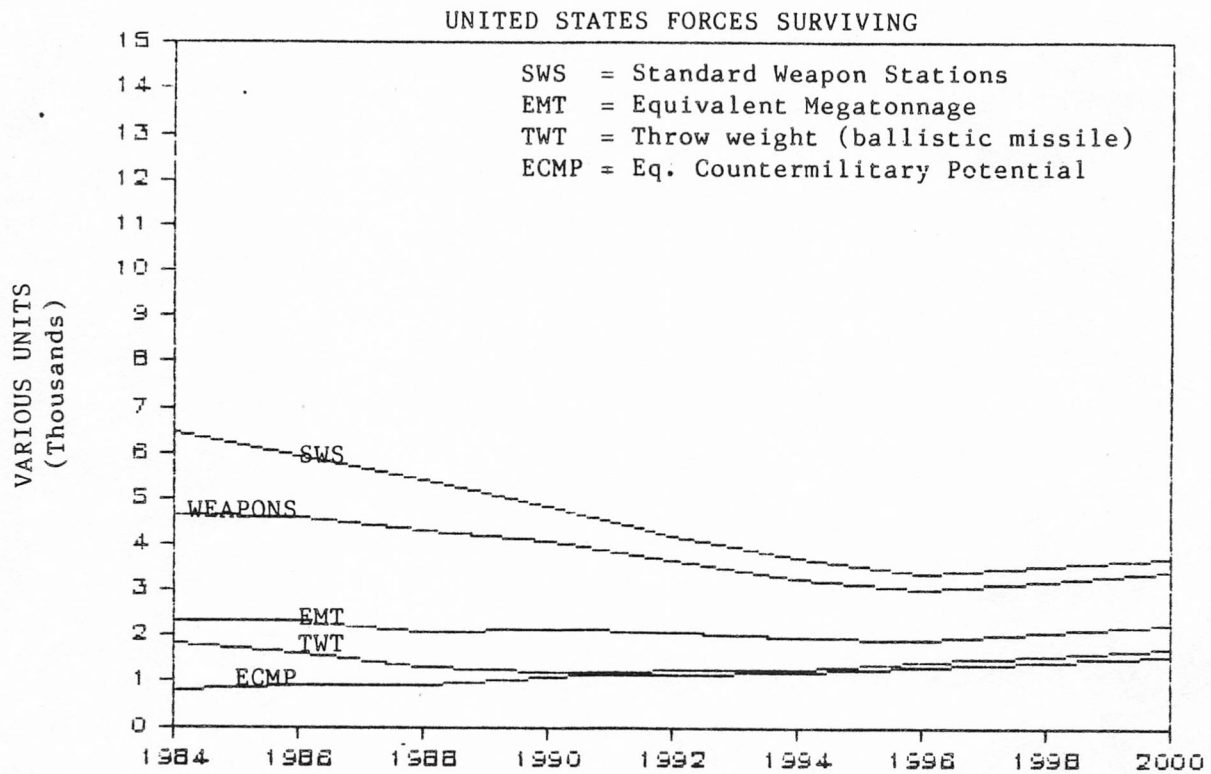
NOTE
DIFFERENT
SCALES





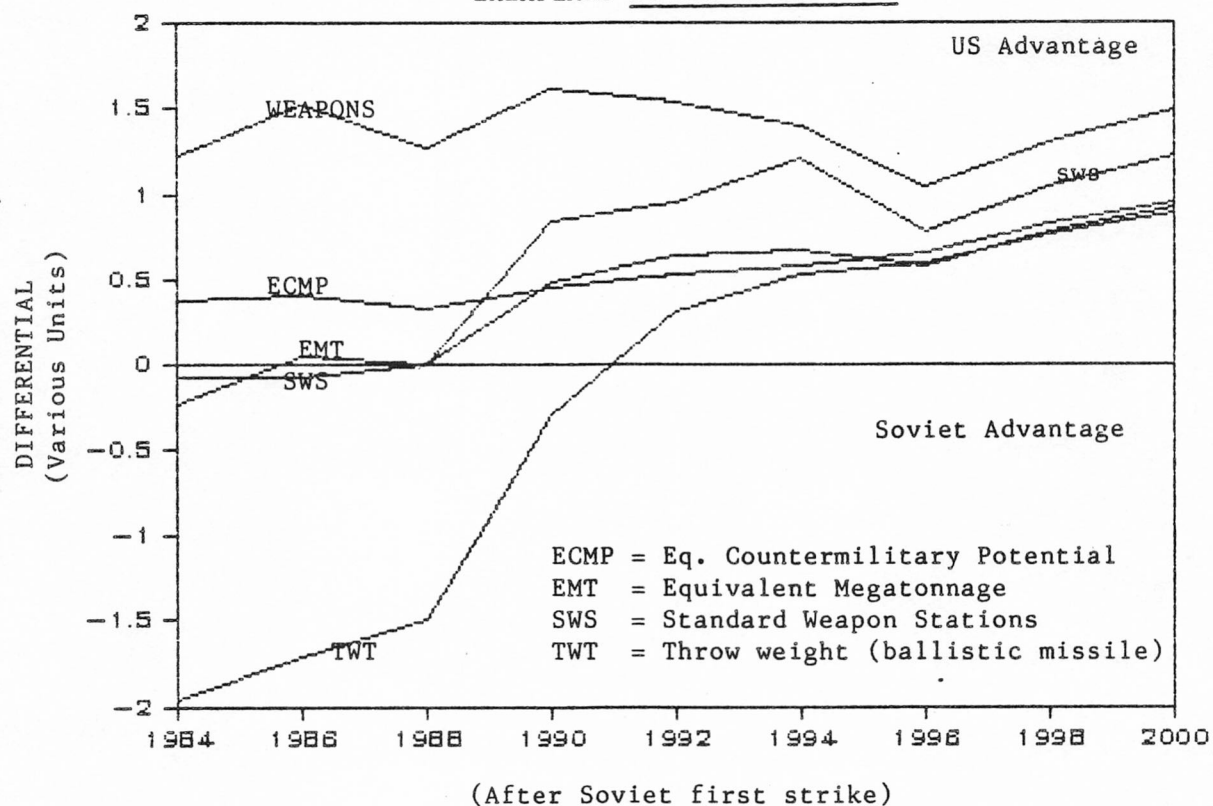
CAPABILITIES AFTER SOVIET
FIRST STRIKE
EXEMPLARY DOUBLE BUILD DOWN

FIGURE 3-7



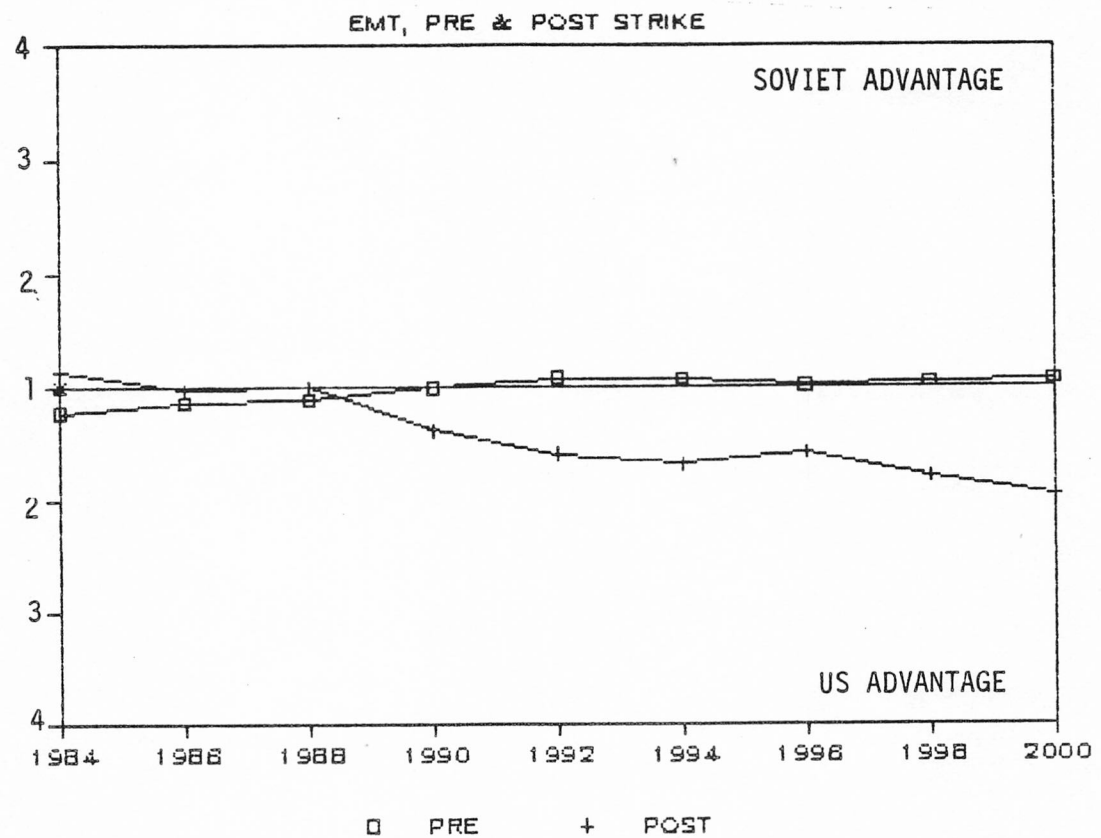
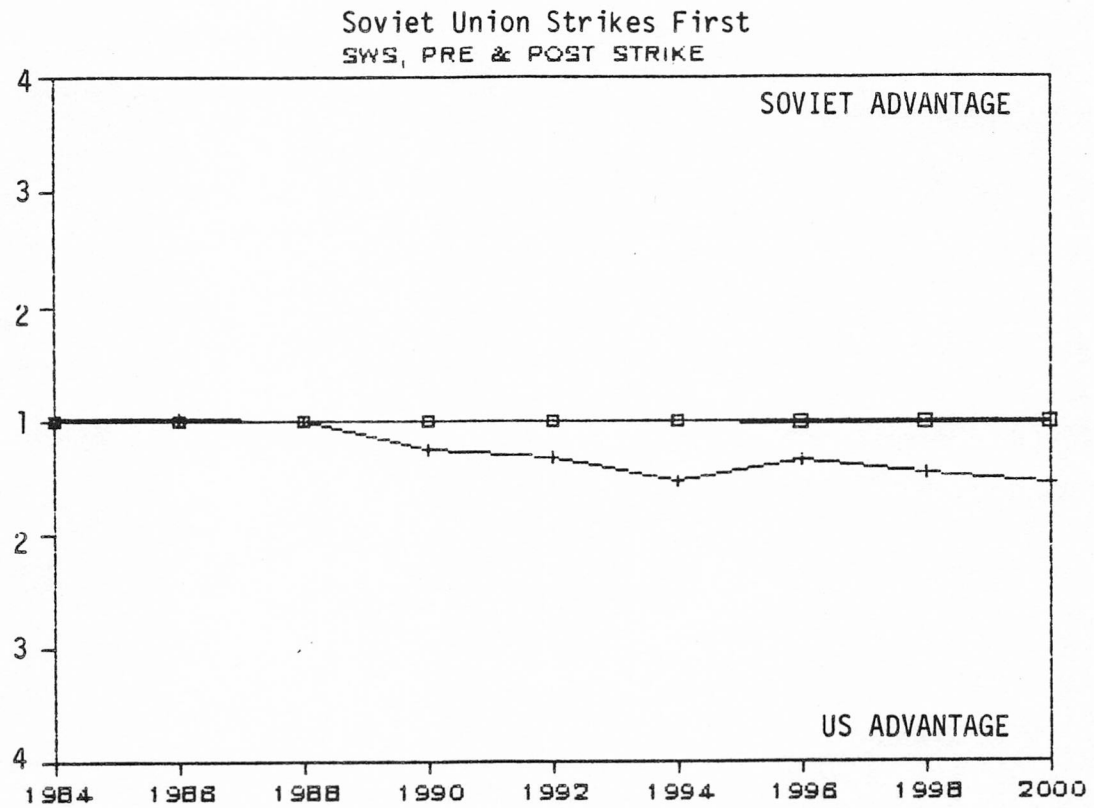
COMPARISON OF ALTERNATIVE
INDICES OF CAPABILITY
(After a counter-force exchange)

EXEMPLARY DOUBLE BUILD DOWN



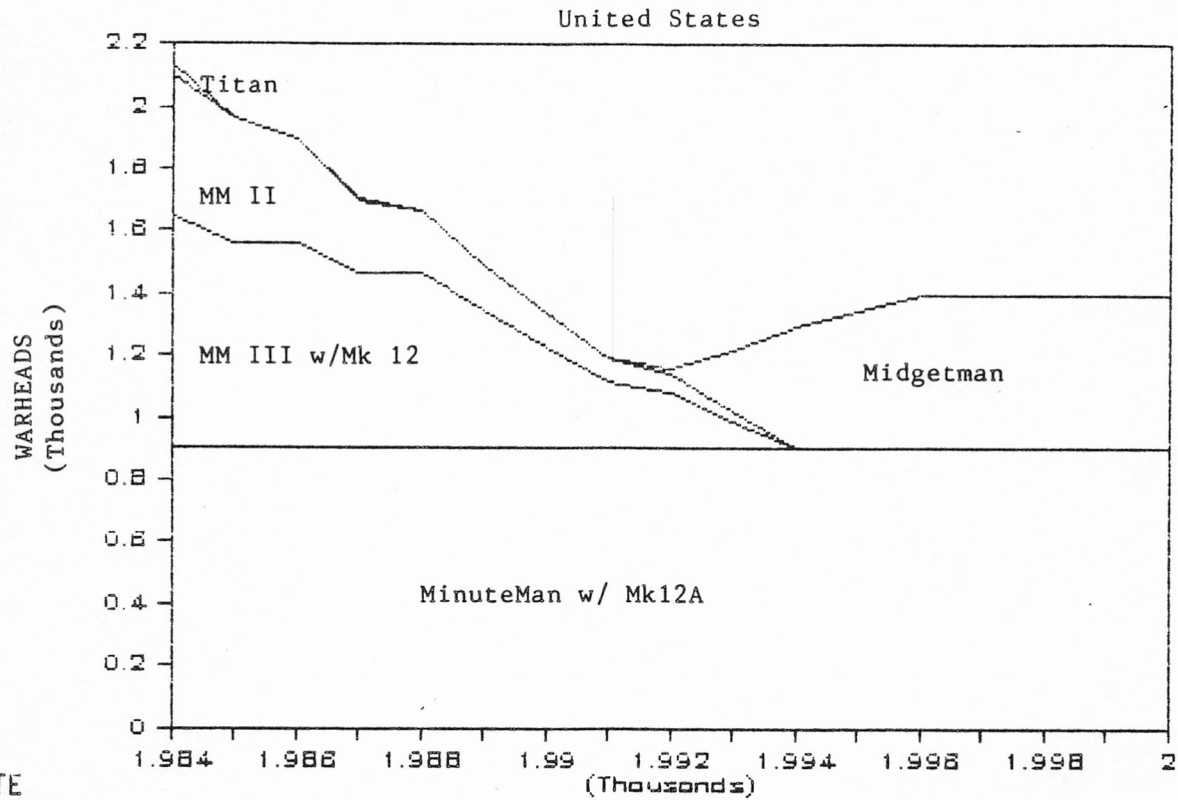
SOVIET - US
STANDARD WEAPON STATION and
EQUIVALENT MEGATONNAGE RATIOS
DOUBLE BUILD DOWN

FIGURE 3-9

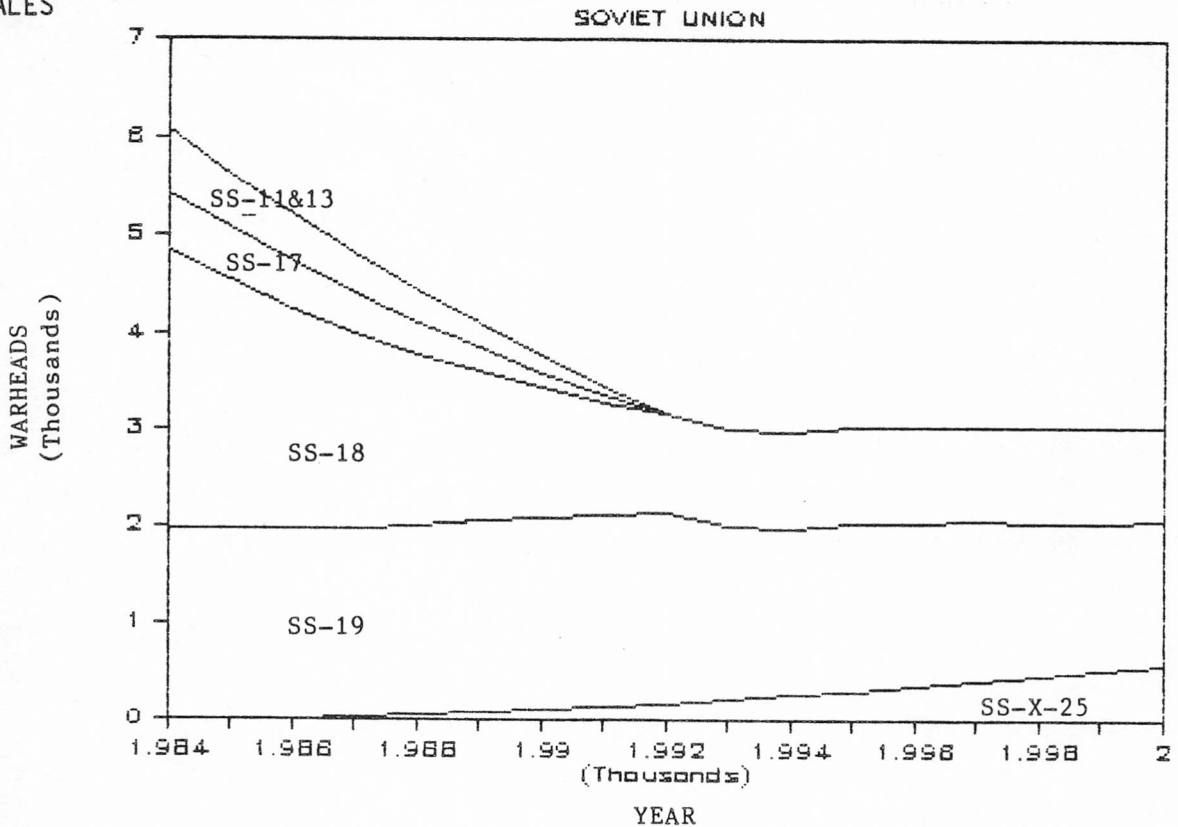


EXEMPLARY ICBM FORCE COMPOSITIONS
 UNDER DOUBLE BUILD DOWN:
LIMITED MODERNIZATION

FIGURE 3-10

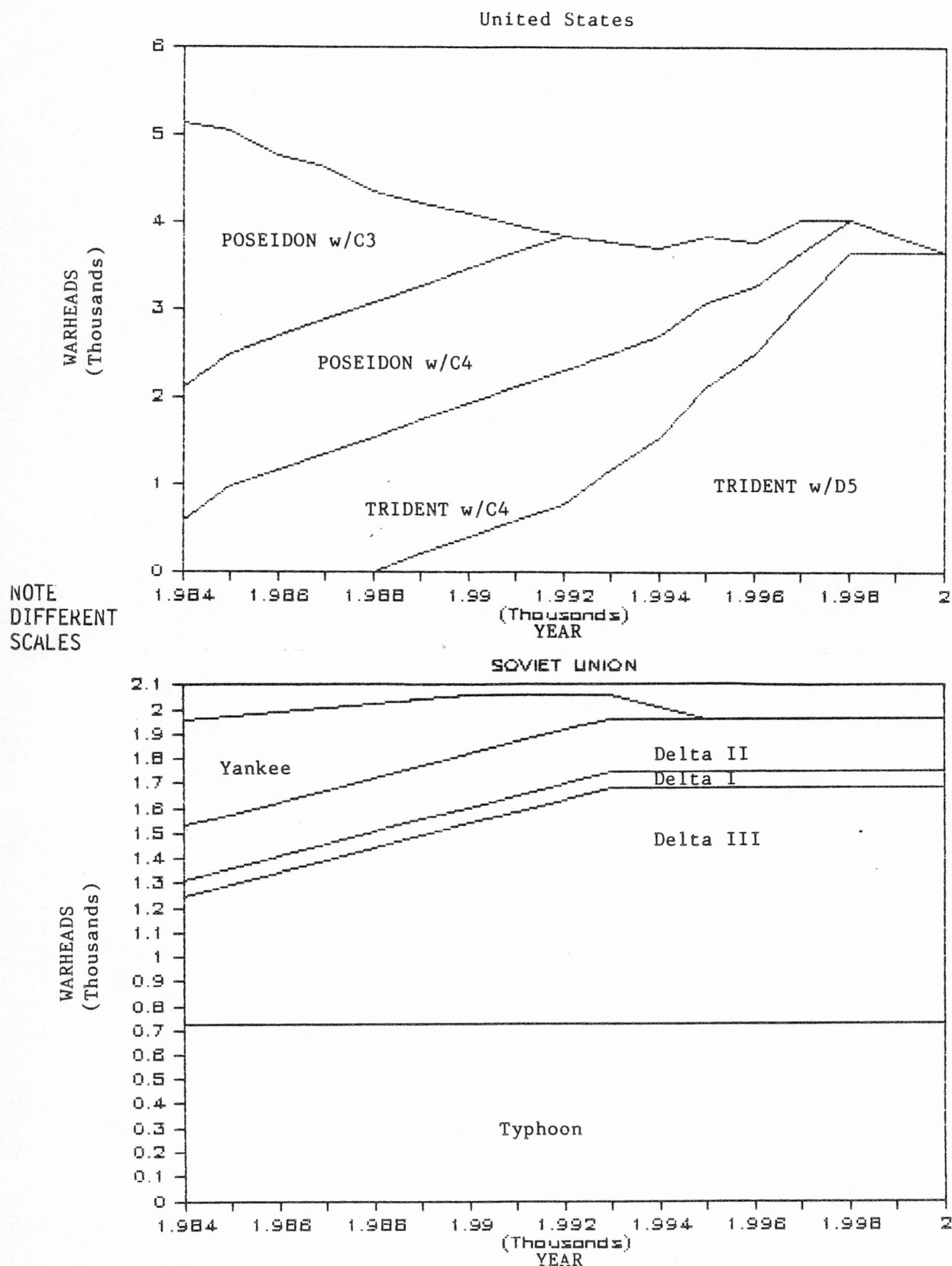


NOTE
 DIFFERENT
 SCALES



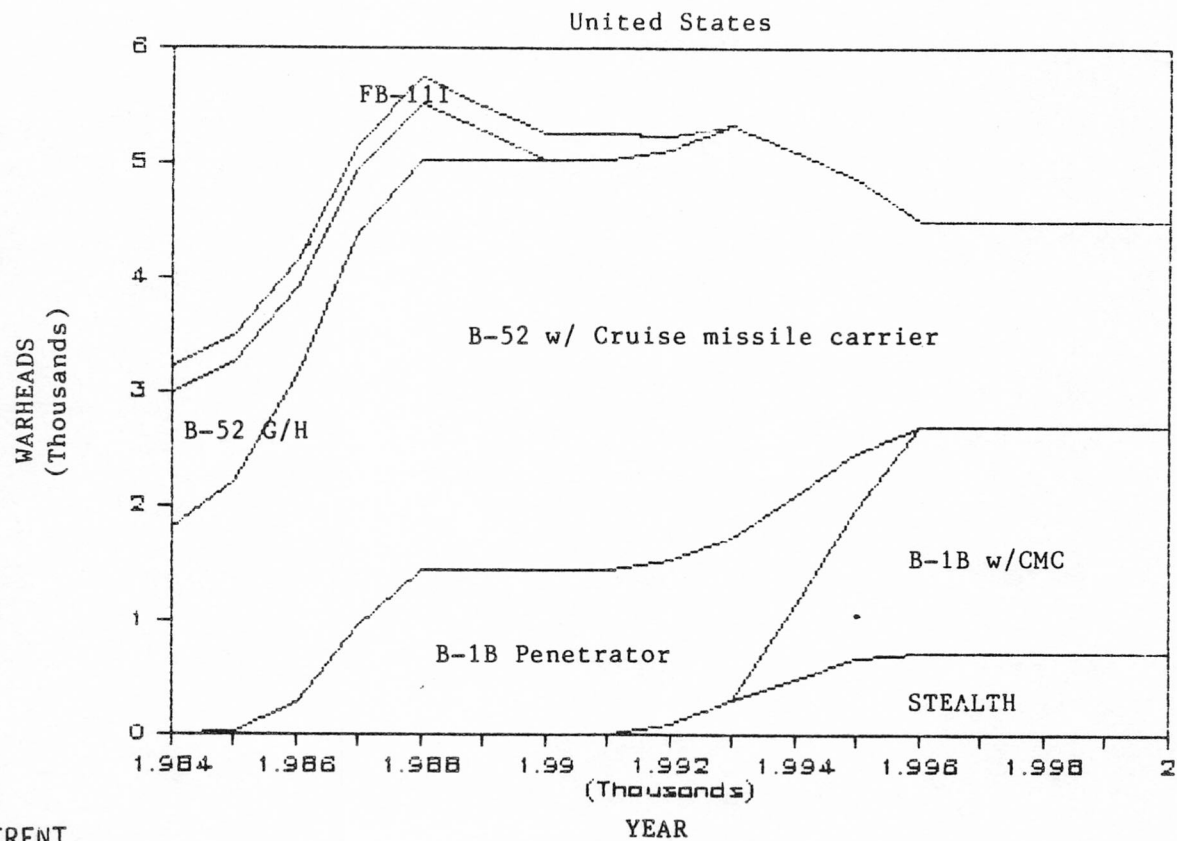
EXEMPLARY SLBM FORCE COMPOSITIONS
 UNDER DOUBLE BUILD DOWN:
LIMITED MODERNIZATION

FIGURE 3-11

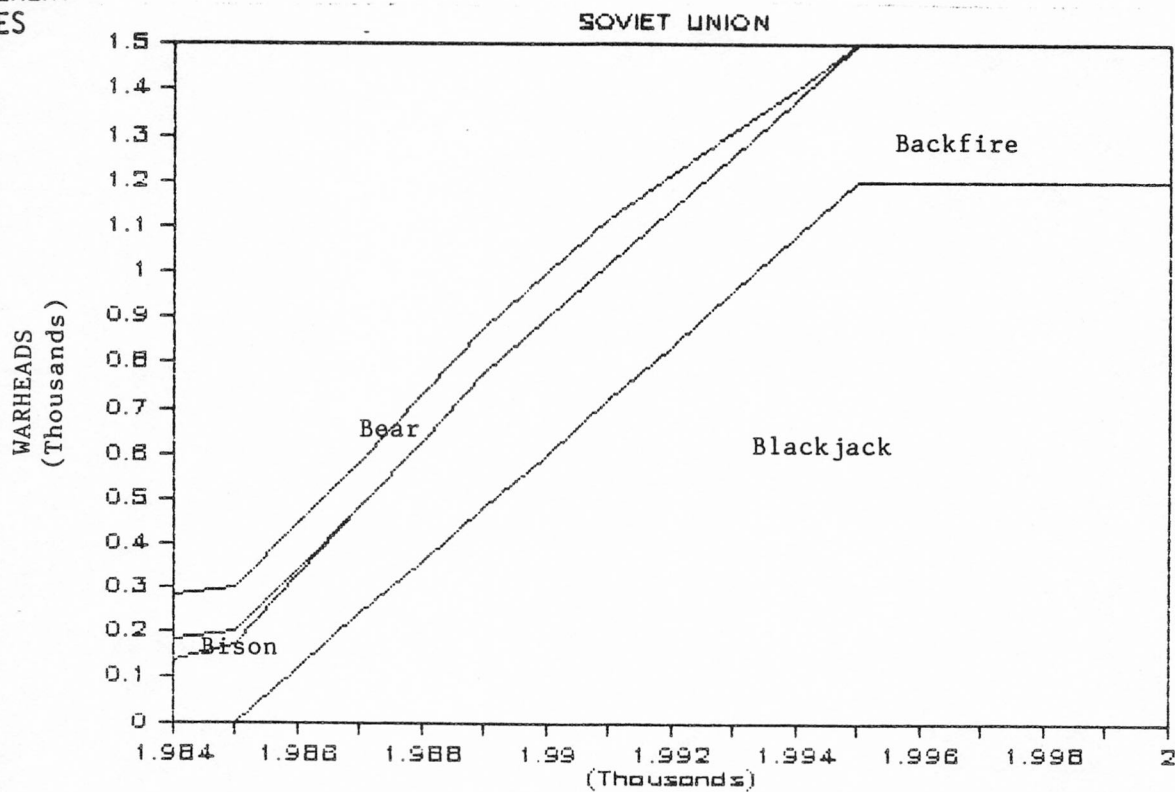


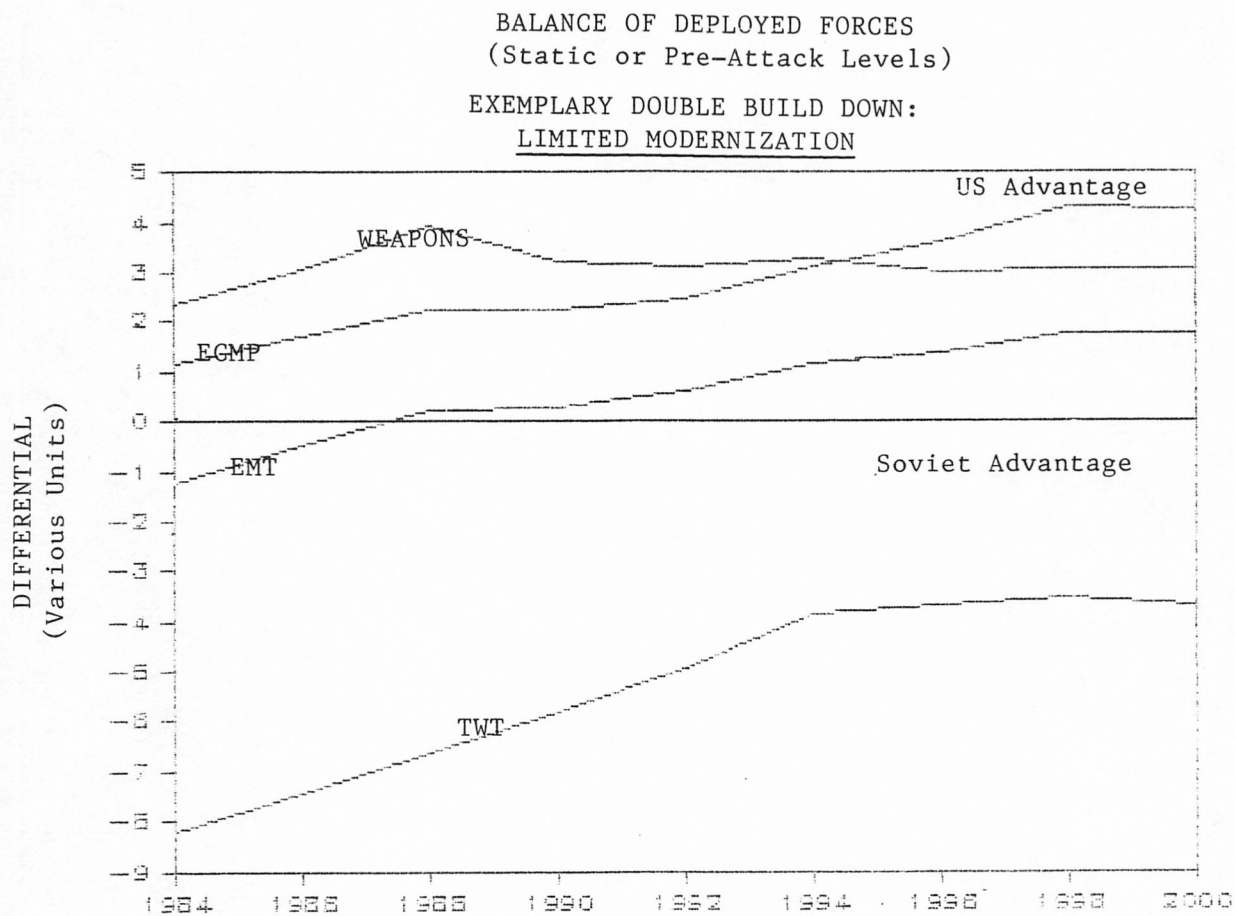
EXEMPLARY BOMBER FORCE COMPOSITIONS
 UNDER DOUBLE BUILD DOWN:
LIMITED MODERNIZATION

FIGURE 3-12



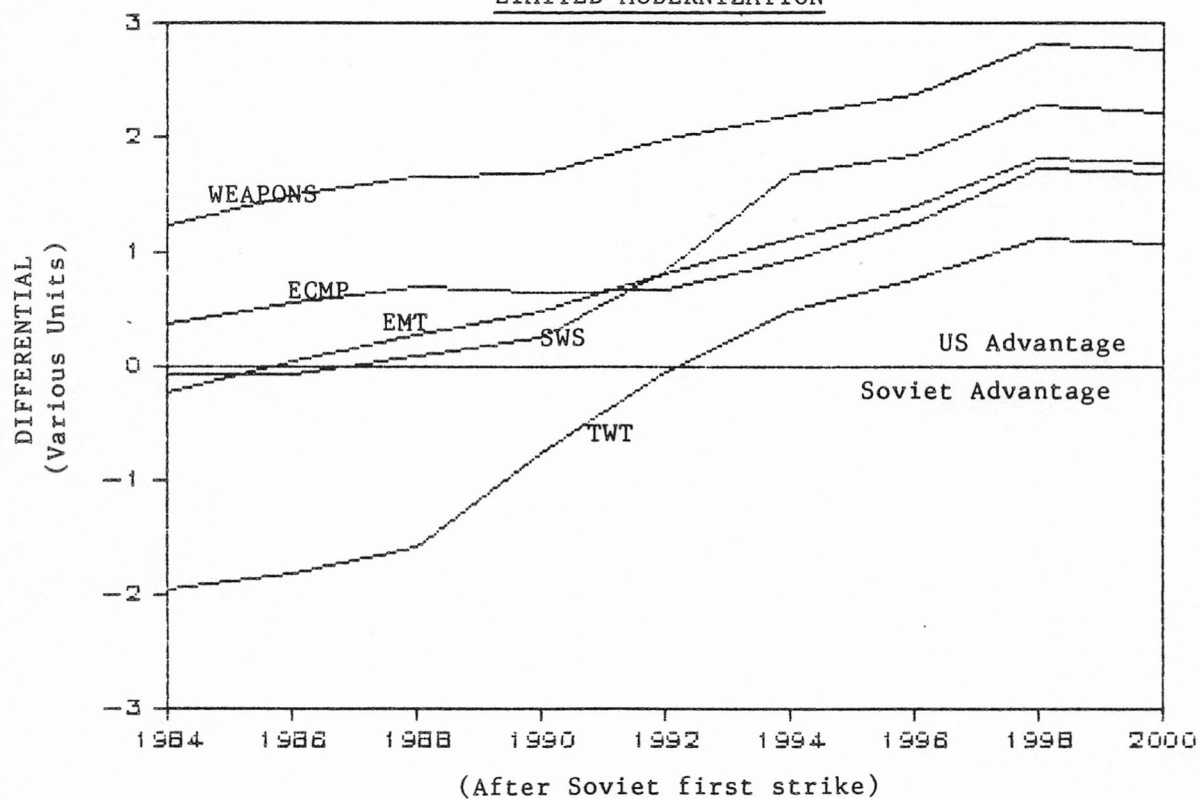
NOTE
 DIFFERENT
 SCALES





COMPARISON OF ALTERNATIVE
INDICES OF CAPABILITY
(After a counter-force exchange)

EXEMPLARY DOUBLE BUILD DOWN:
LIMITED MODERNIZATION



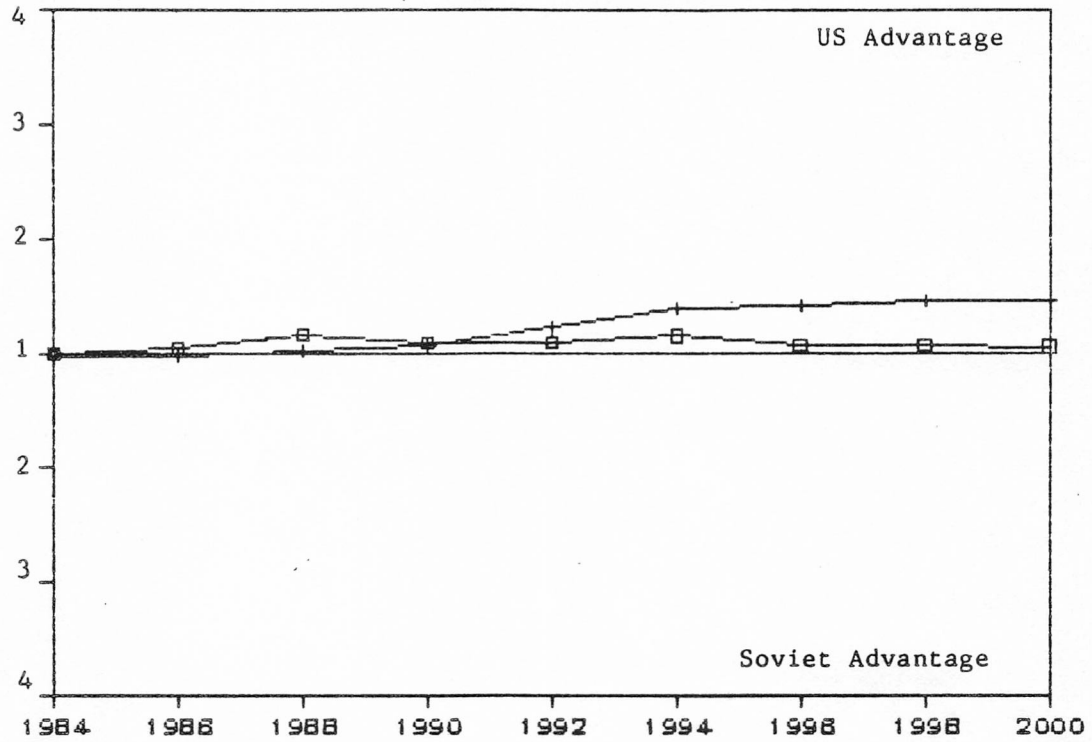
SOVIET - US

FIGURE 3-15

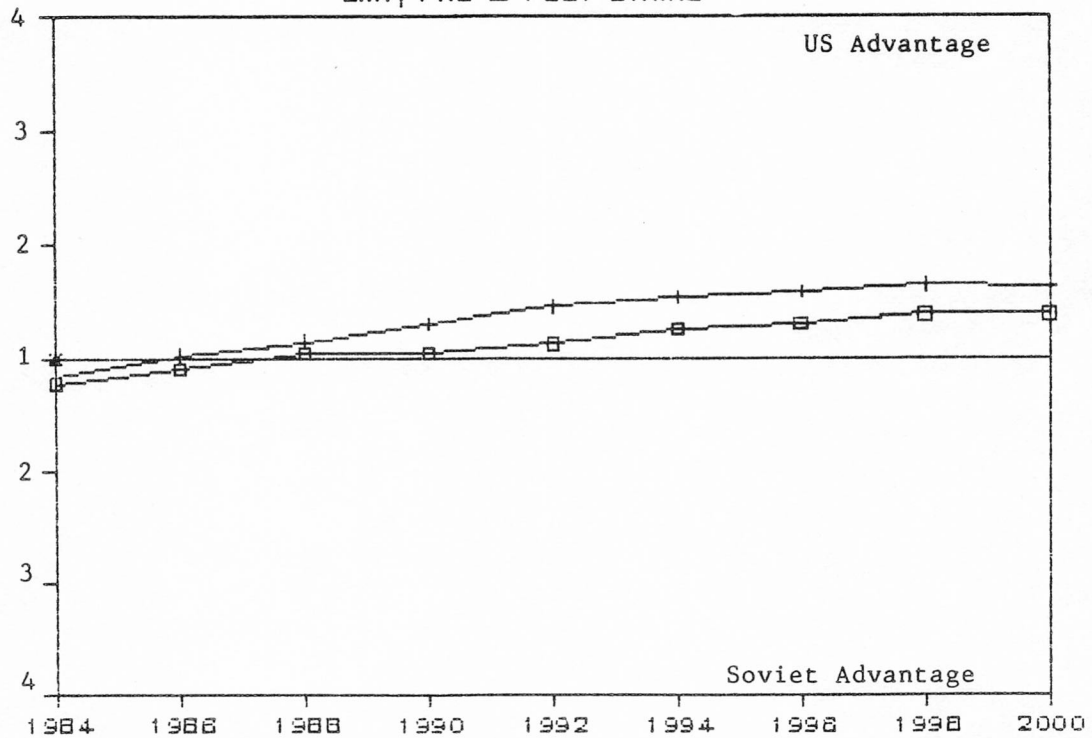
STANDARD WEAPON STATION and
EQUIVALENT MEGATONNAGE RATIOS

DOUBLE BUILD DOWN:
LIMITED MODERNIZATION

Soviet Union Strikes First
SWS, PRE & POST STRIKE

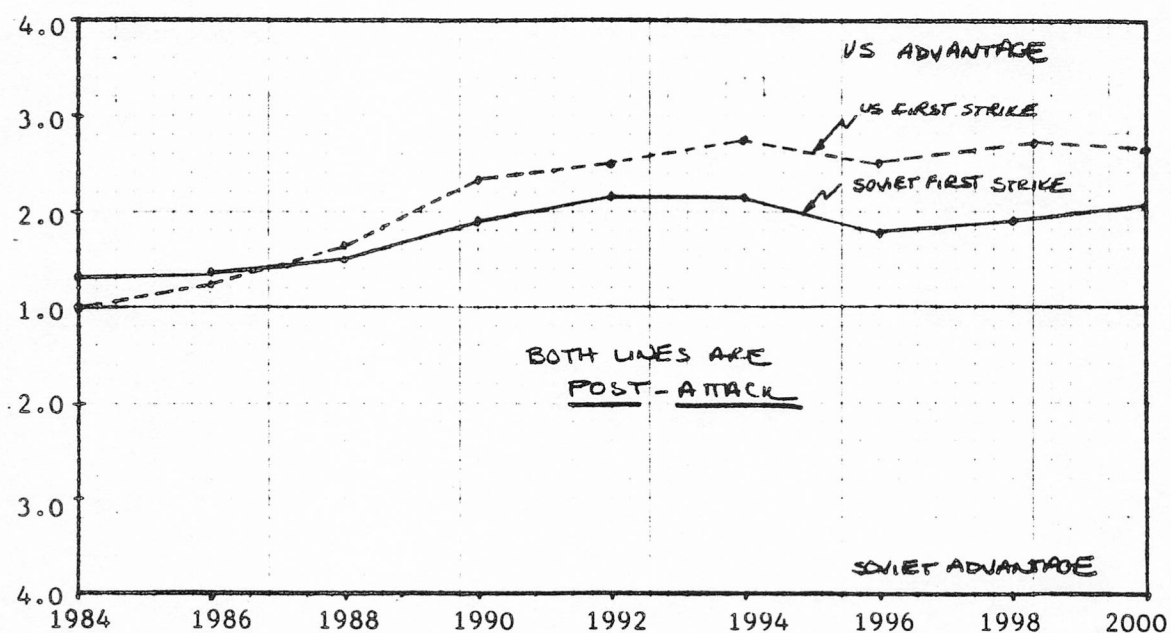


EMT, PRE & POST STRIKE

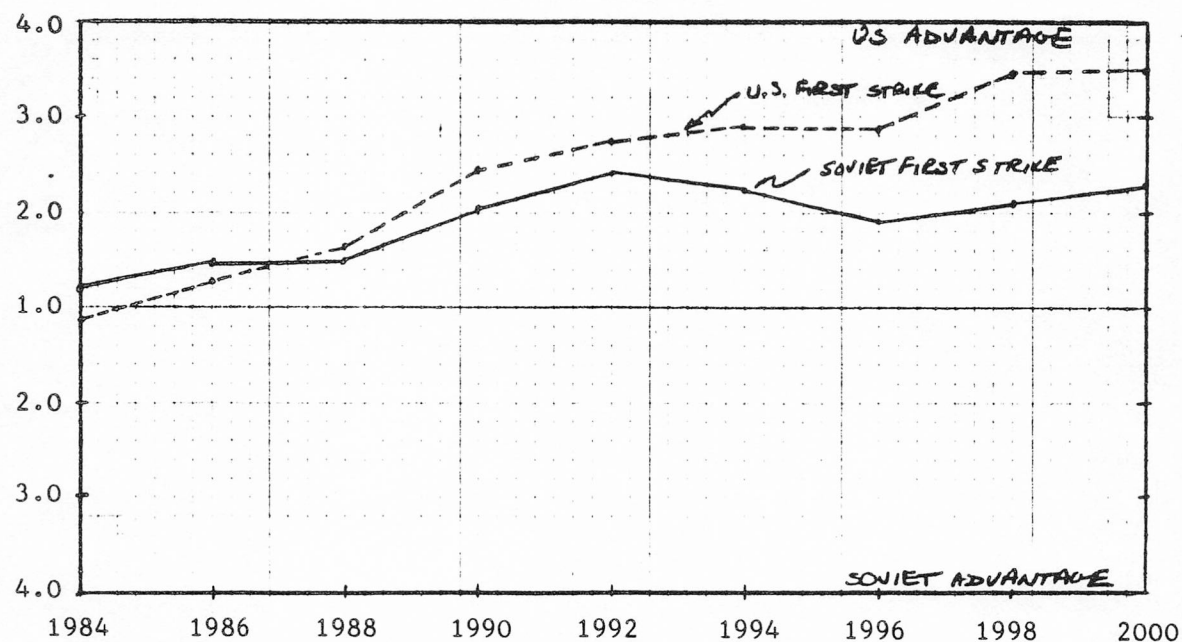


□ PRE + POST

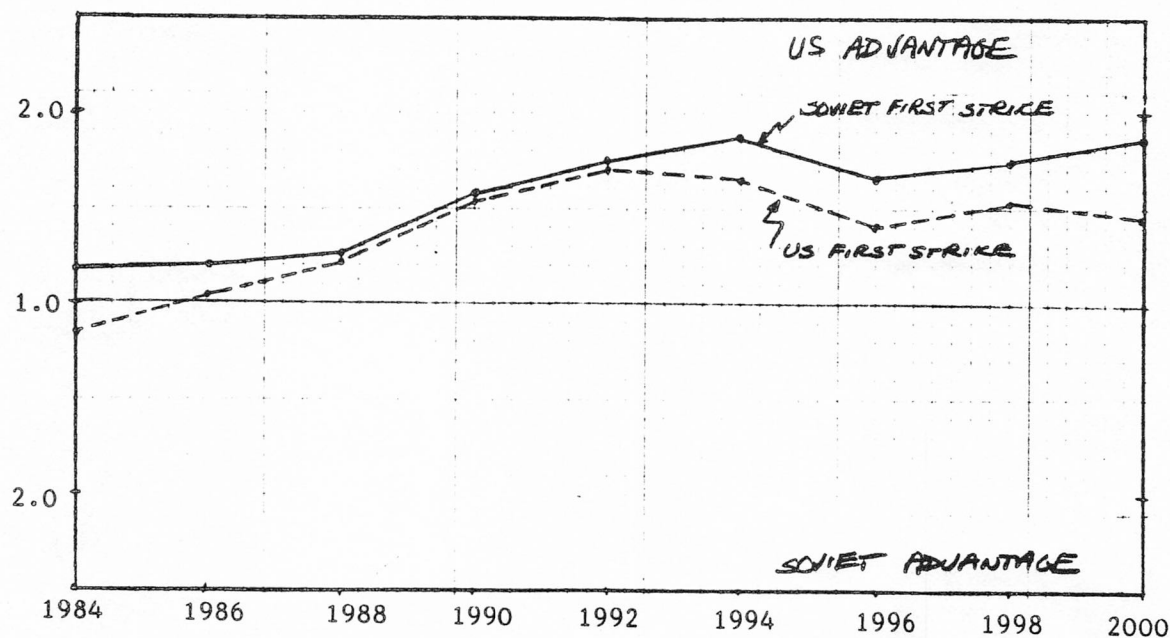
SOVIET - U.S. RATIOS OF ADVANTAGE
GENERATED ALERT CASE
STANDARD WEAPON STATIONS



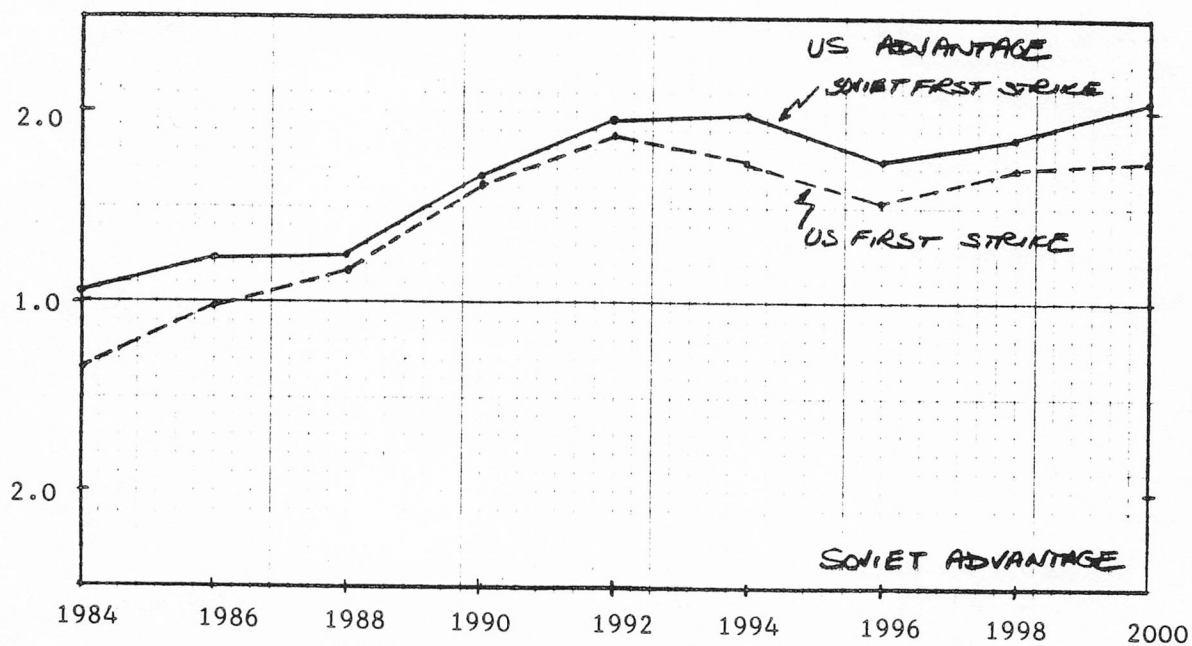
EQUIVALENT MEGATONNAGE



SOVIET - U.S. RATIOS OF ADVANTAGE
 3500 PSI SOVIET SILO / GENERATED ALERT
STANDARD WEAPON STATIONS

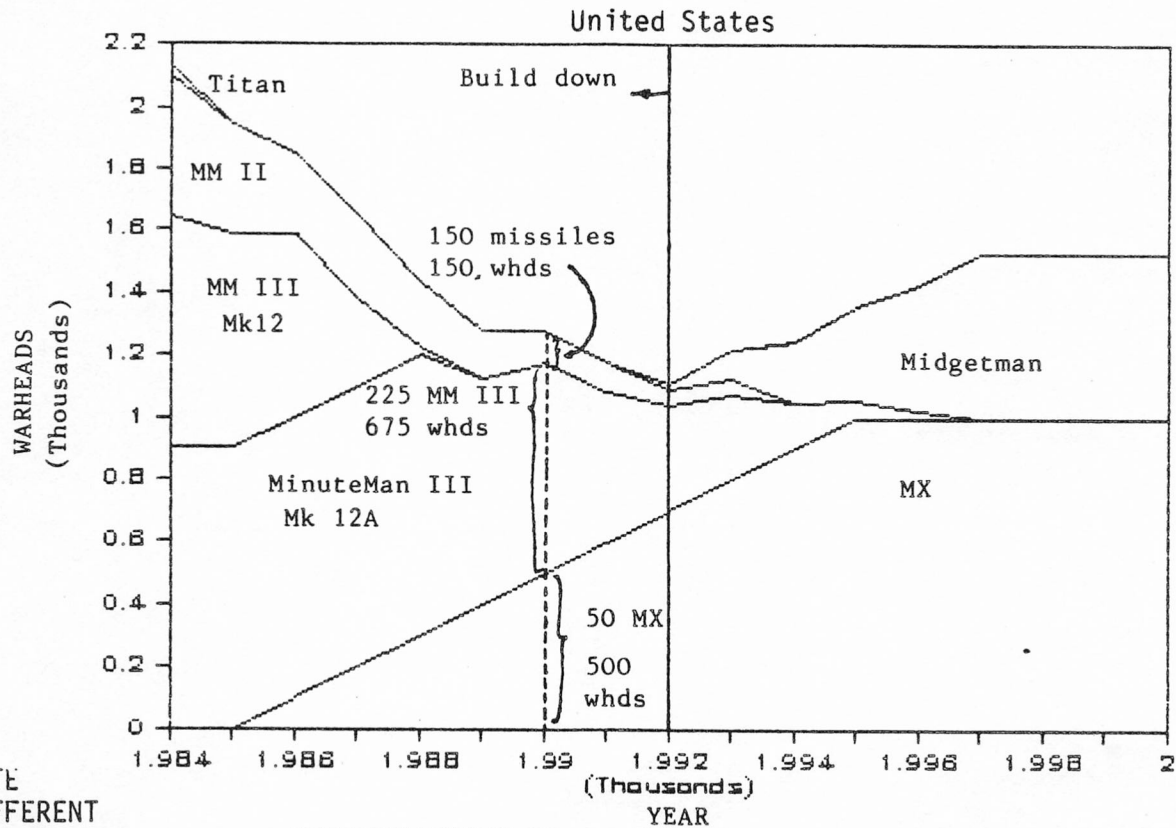


EQUIVALENT MEGATONNAGE

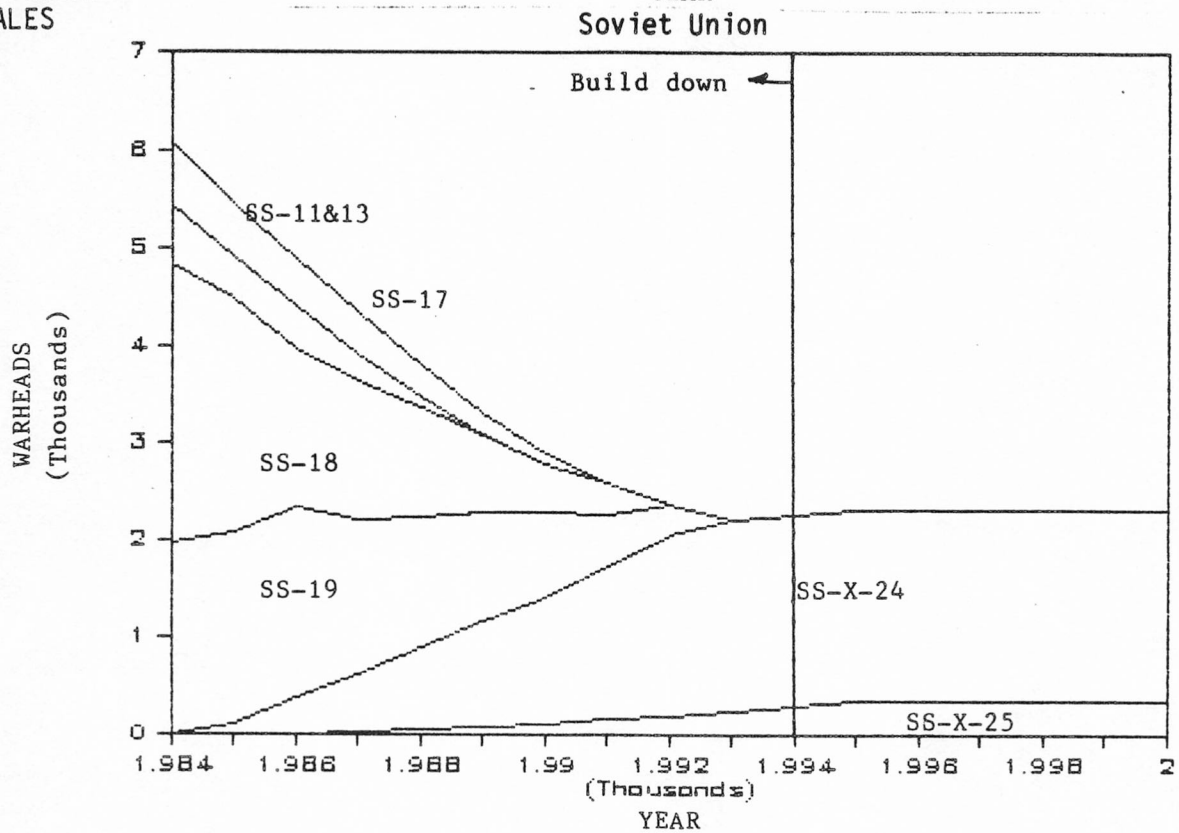


EXEMPLARY ICBM FORCE COMPOSITIONS
UNDER SINGLE BUILD DOWN

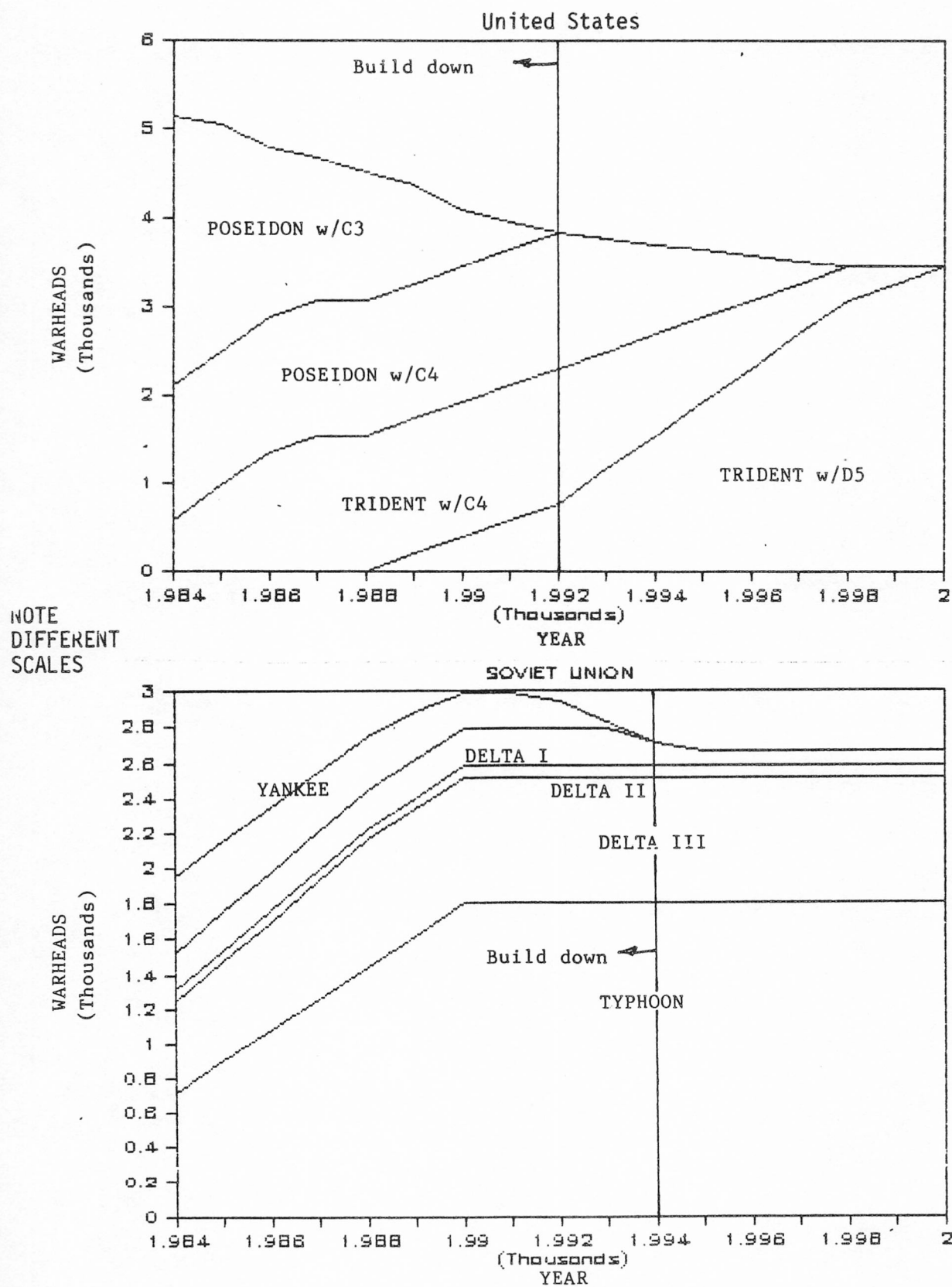
FIGURE 3-18



NOTE
DIFFERENT
SCALES

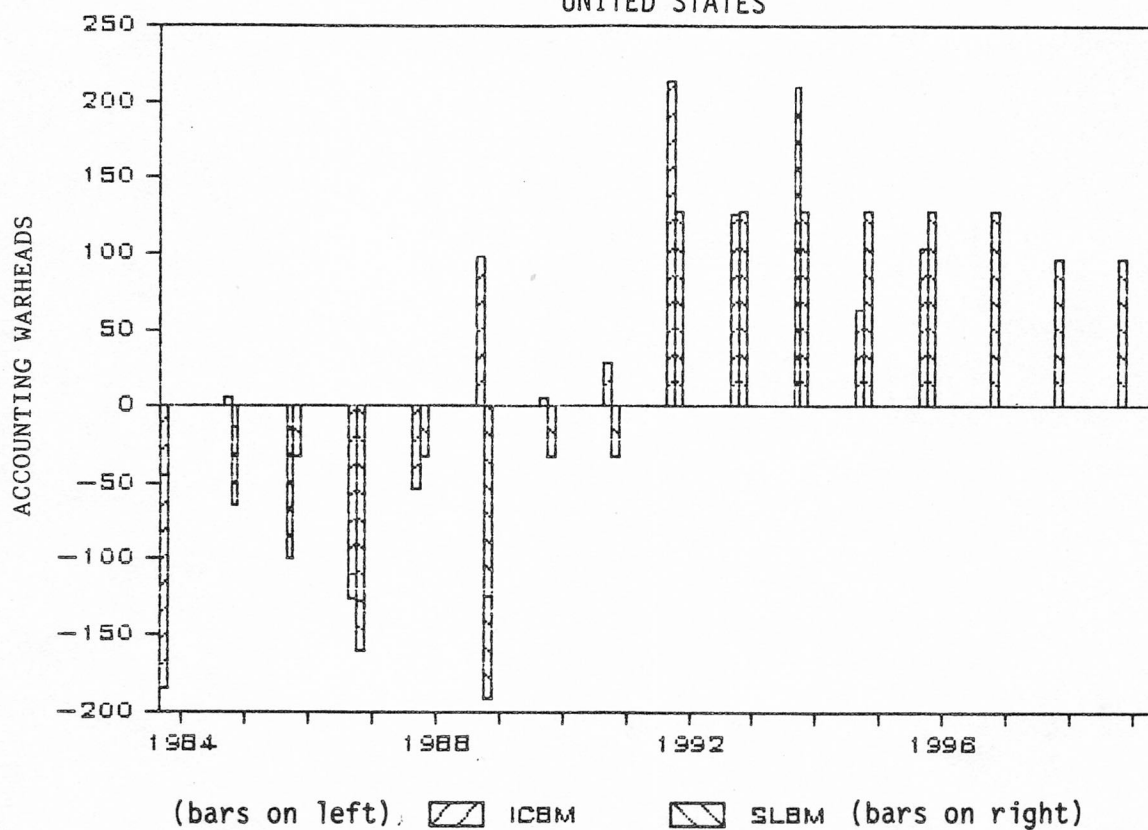


EXEMPLARY SLBM FORCE COMPOSITIONS UNDER SINGLE BUILD DOWN

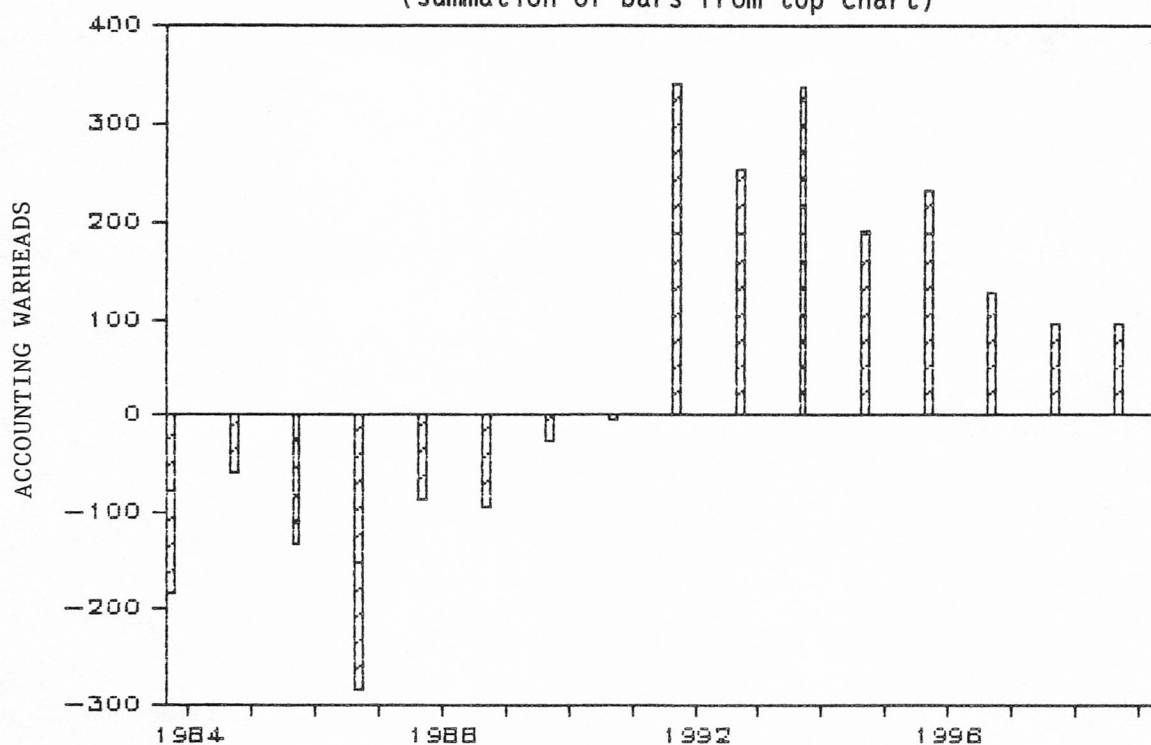


CHANGES IN COMPONENTS OF
BALLISTIC MISSILE FORCE (Warheads)
UNDER SINGLE BUILD DOWN

UNITED STATES

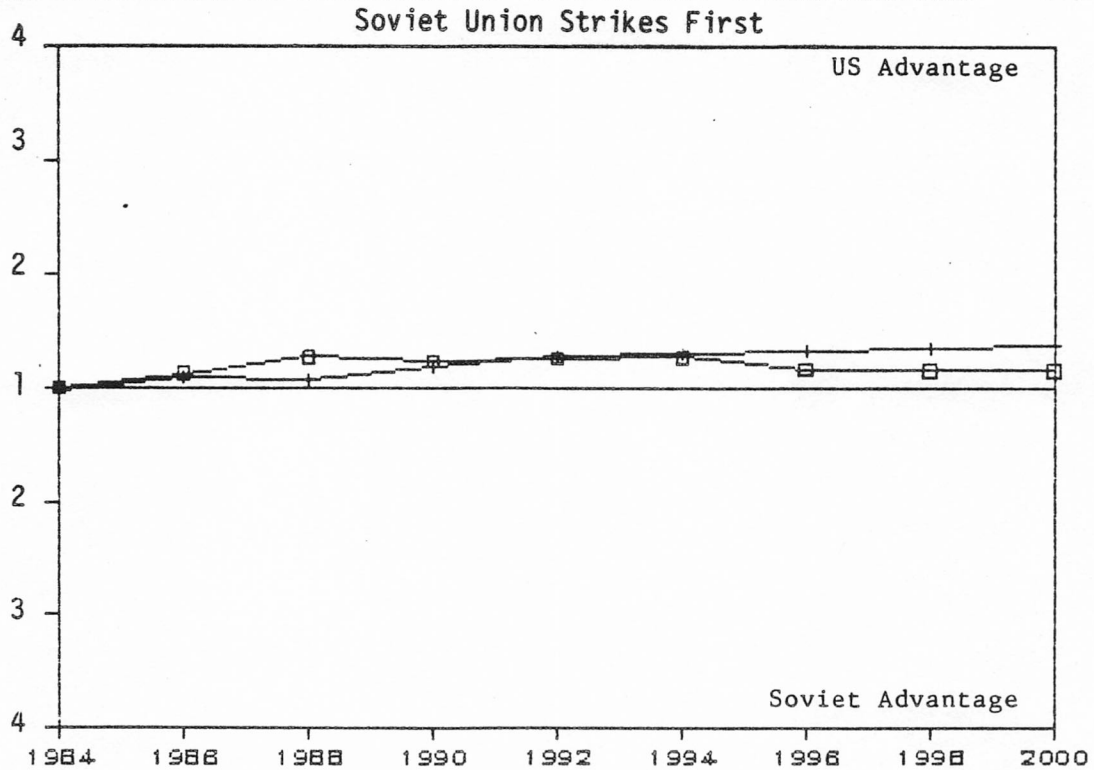
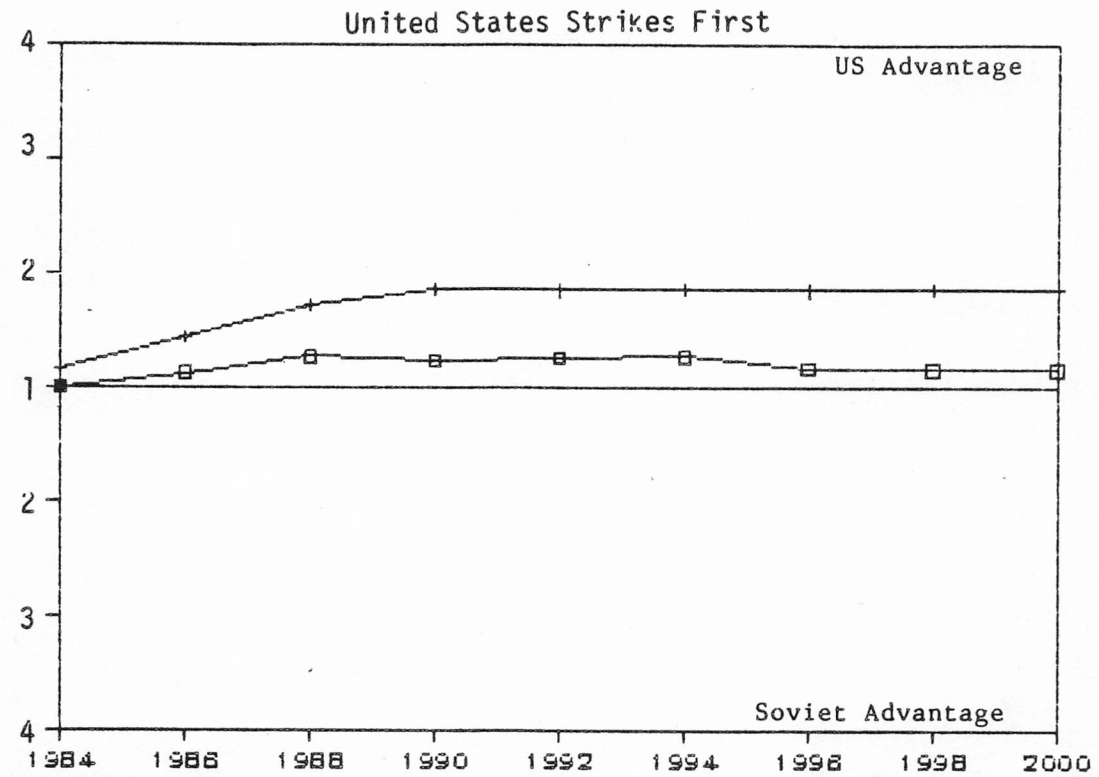


CHANGES IN BALLISTIC MISSILE
WARHEAD TOTALS
(summation of bars from top chart)



SOVIET - US
STANDARD WEAPON STATION RATIOS
SINGLE BUILD DOWN

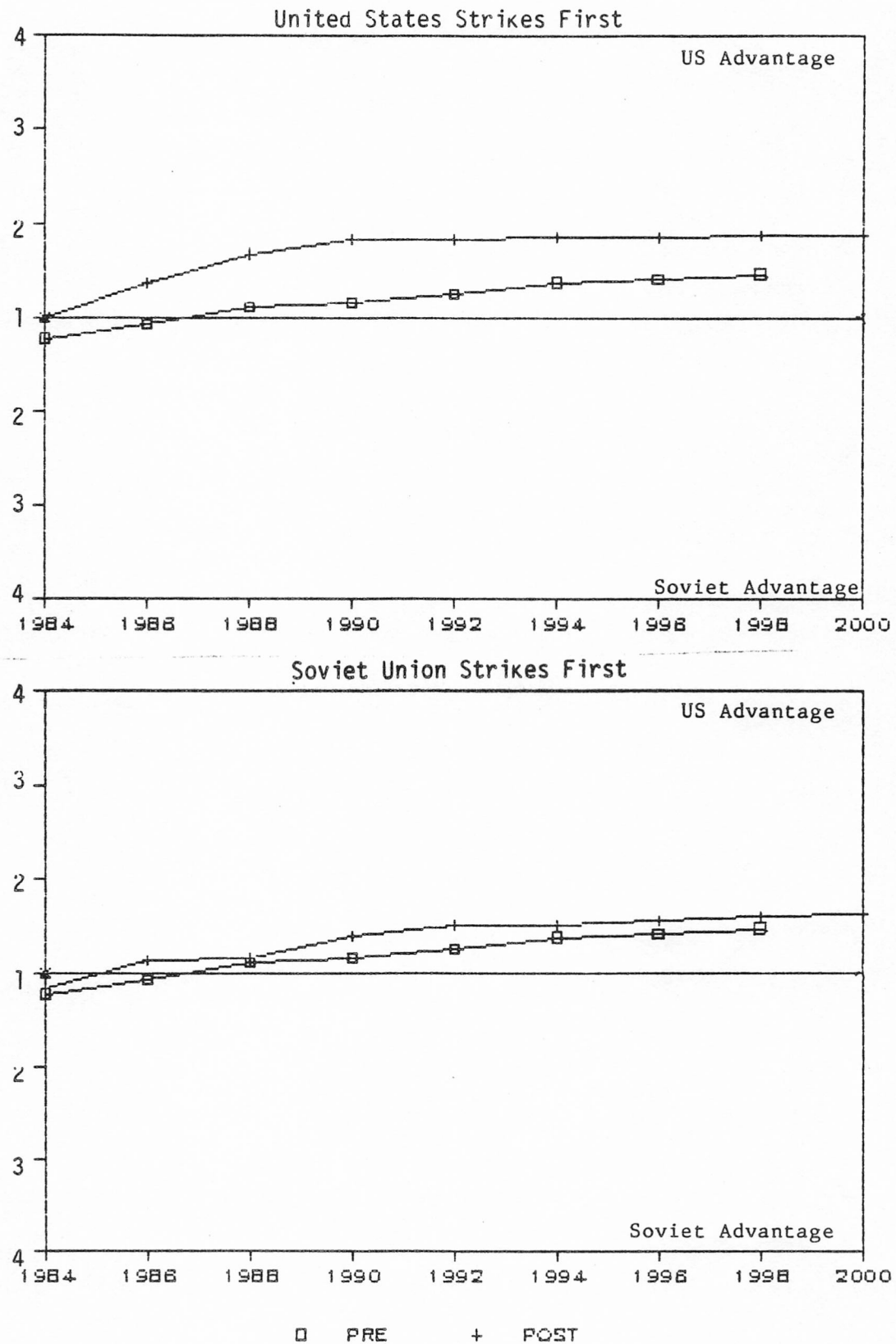
FIGURE 3-21



□ PRE + POST

SOVIET - US
EQUIVALENT MEGATONNAGE RATIOS
SINGLE BUILD DOWN

FIGURE 3-22



APPENDIX A

METHODOLOGICAL WEAKNESSES

As useful as it may be, this method of judging stability of the nuclear deterrent gives an incomplete view of the threat of nuclear war. Figure A-1 lists some weaknesses in the methodology; these are divided into weaknesses of assumption, and of technique. The former call into question the logical validity of using a counterforce exchange / margins of advantage approach to making judgments about stability. The latter refer to the limited usefulness of modeling to describe events of which there is little empirical data, the continued lack of which is the goal of this analysis. The model itself is also full of simplifying assumptions, made for lack of knowledge or data; many of these have not been examined for the effect changes in them would have on the outcome of the analysis.

The weaknesses of assumption are suggested by the first three bullets of Figure A-1. The counterforce exchange is not necessarily the most likely war by means of nuclear weapons. Figure A-2 shows ranges of contingencies, possible outcomes, and strategies, all of which should be taken into account when thinking about the implications of force modernization and reductions for stability and deterrent sufficiency. There are several contingencies to consider. Which is best served by a counterforce exchange? Is strategic nuclear capability necessary to do other than destroy military targets? If so, what strategies is this capability intended for, for what outcome, to what end, to deter what sort of aggression? Clearly these questions are profound and cannot be answered here. The point is that counterforce exchange examples, used here to help choose among arms control proposals, give limited insight on the desirability of specific policy options. Conclusions drawn on the basis of this analysis are, and must be, equivocal.

Some limitations of the model are listed in the second set of bullets, and there are many more. The cookie cutter damage calculation does not allow for degrees of damage, but prescribes a lexical result: destruction or not. The effects of a nuclear first strike on the command, communication, and control structure necessary to direct a retaliation might limit the effectiveness of a retaliation, but this is not taken into consideration. Submarines at sea are assumed to be prompt, and all SSBNs at sea are assumed to be alert -- neither of these is true. No launch under attack is allowed, although it is reasonable to assume that the side which struck first would launch the remainder of its land based missiles on warning of a retaliatory strike. Some of these assumptions were made for lack of techniques to analyze information, resources to process information, or information itself. Others were made as legitimate simplifications which it was thought would not bias the results.

These weaknesses should be kept in mind when citing the results of this analysis, or setting out to improve on it.

WEAKNESSES OF THE METHODOLOGY...

... OF ASSUMPTION:

- COUNTERFORCE EXCHANGE DOES NOT ADDRESS ALL CONTINGENCIES IN WHICH NUCLEAR FORCES MIGHT BE USED.
- RESPONSE TO COUNTERFORCE NEED NOT BE COUNTERFORCE.
- MEASUREMENT OF RELATIVE ADVANTAGE IS SLIPPERY.

... OF TECHNIQUE:

- COOKIE CUTTER DAMAGE CALCULATION.
- NO LINK BETWEEN C³ DESTRUCTION AND RETALIATORY CAPABILITY.
- SUBMARINES ARE ASSUMED TO BE PROMPT.
- SOVIET AIR DEFENSES ARE NOT TARGETED.
- TARGET ASSIGNMENTS ARE NOT OPTIMAL
- NO LAUNCH UNDER ATTACK ON 2ND STRIKE.
- MANY, MANY MORE

ASSESSING THE CAPABILITIES OF NUCLEAR FORCES

CONTINGENCIES ?

- CONVENTIONAL ATTACK ON ALLIES
- NUCLEAR ATTACK ON ALLIES
- NUCLEAR ATTACK ON UNITED STATES

OBJECTIVES ?

- "ACCEPTABLE" OUTCOMES
- CREDIBILITY
- STABILITY

POSSIBLE OUTCOMES ?

- DESTRUCTION
- DISARM AND DESTROY
- DISARM, LIMIT DAMAGE, DESTROY
- DISARM, COERCE
- INVADE
- DENY

STRATEGIES ?

- ASSURED DESTRUCTION
- COUNTERFORCE, ASSURED DESTRUCTION
- COUNTERFORCE, COERCION
- STRATEGIC BOMBING WITH ASSURED DESTRUCTION RESERVE
- COUNTERVAILING WITH ASSURED DESTRUCTION RESERVE

APPENDIX B

BUILD DOWN WORKSHEET EXAMPLE

Figure B-1 shows the development of a Soviet force posture for 1986 under the double build down. The straight line reduction requirement on warheads and standard weapon stations calls for annual cuts of 379 warheads and 515 SWS. The force posture in the years 1984 and 1985 has already been determined, and reductions in 1986 begin with iteration #1 -- the user chooses a level of reductions, recalculates the worksheet, and examines the results, to see if the cuts are sufficient.

Iteration #1 shows a cut of 236 warheads and the addition of 28 SWS, clearly an inadequate result. In iteration #2, the user chooses to further reduce SS-11, SS-13, and SS-17 missiles, to retire one more Yankee submarine, and 5 Bear bombers. This results in the loss of more warheads than is necessary, and yet still not enough SWS. The solution is to add back some of the missile warheads, and to lose the SWS by cuts in bombers, as shown in iteration #3. This gives the desired result.

Often it takes 10 or more iterations to arrive at a satisfactory force in any one year. The warhead and SWS numbers in the upper right hand corner serve as multiplicands for the numbers of strategic nuclear delivery vehicles, used to determine the warhead and SWS totals. The advantage to using Supercalc for the build down is apparent: recalculations are completed in seconds, so that the interactive build down of forces can be accomplished quickly.

FIGURE B-1

Using the build
down worksheet:
an example

ITERATIONS

DOUBLE BUILD DOWN WORKSHEET EXAMPLE				#1	#2	#3				
SYSTEM	1984	1985	1986	1986	1986	1986	WGT	WHD	WGT	SWS
SS-11	570	400	400	250	220	230	1	1	2.0	2.0
SS-13	60	25	25	15	10	10	1	1	1.4	1.4
SS-17	150	130	130	130	100	105	4	4	6.8	6.8
SS-18 one	24	24	24	24	24	24	1	1	19.	19.
mirv in	284	284	284	284	284	284	20	10	19.	19.
mirv out	0	0	0	0	0	0	10	10	19.	19.
SS-19 mir	330	330	330	330	330	330	12	6	8.5	8.5
mirv out	0	0	0	0	0	0	6	6	8.5	8.5
SSX24 MXs	0	0	0	0	0	0	20	10	10	10
PL-5 mobil	0	0	0	0	0	0	1	1	2.7	2.7
YANKEE	27	22	22	18	17	17	16	16	23.	23.
DELTA I	18	17	17	16	16	16	12	12	20.	20.
DELTA II	4	4	4	4	4	4	16	16	26.	26.
DELTA III	11	11	11	11	11	11	72	48	48	48
DELTA III	0	0	0	0	0	0	48	48	48	48
TYPHOON	4	4	4	4	4	4	270	180	180	180
BEAR	100	100	100	100	95	89	1	1	8.3	8.3
BISON	45	45	45	45	45	15	1	1	7	7
BACKFIRE	70	96	96	120	120	120	2	2	5.5	5.5
BLACKJACK	0	0	0	20	20	20	24	12	16	16
whd tgt	yr	1992	#	#	#	#				
acct whds	*****	*****	*****	*****	*****	*****				
ICBM non mirv	-205	0	-160	-195	-185					
ICBM mirv	-80	0	0	-120	-100					
SLBM	-92	0	-76	-92	-92					
TOTAL	-172	0	-76	-212	-192					
ids	*****	*****	*****	*****	*****	*****				
ICBM	6074	5789	5789	5629	5474	5504				
	-285	0	-160	-315	-285					
SLBM	1960	1868	1868	1792	1776	1776				
	-92	0	-76	-92	-92					
MISL TOTL	8034	7657	7657	7421	7250	7200				
DELTA	-379	-377	0	-236	-407	-377				
BOMBERS	205	337	337	625	620	584				
TOTAL	8319	7994	7994	8046	7870	7864				
sws	*****	*****	*****	*****	*****	*****				
ICBM	10816	10293	10293	9980	9708	9762				
	-523	0	-313	-584	-530					
SLBM	2331	2196	2196	2083	2060	2060				
	-136	0	-112	-136	-136					
LRB	1532	1676	1676	2129	2087	1820				
	144	0	453	412	152					
TOTAL	14679	14164	14164	14192	13856	13650				
DELTA	-515	-515	0	28	-309	-514				
misc measures	*****	*****	*****	*****	*****	*****				
MISL WHD%	-4.69	0	-3.08	-5.32	-4.92					
MISL HDTK	24	24	24	24	24	24				
HDTGT K	309	361	361	649	644	608				
SILOS	1418	1193	1193	1033	968	983				
SLBM LNCR	968	876	876	800	784	784				
BOMBERS	215	241	241	285	280	244				

APPENDIX C

FORMULAS FOR AGGREGATE MEASURES

ECMP

ECMP = equivalent countermilitary potential

$$= \frac{\text{Ln} \left(1 - r + r * 0.5^{(\text{CMP} * \text{LR}^2)} \right)}{\text{Ln}(0.5) * \text{LR}^2}$$

where: ^X means 'to the X power'.

r = probability that the warhead will arrive at the target.

CMP = countermilitary potential

= (Yield^{2/3}) / (CEP²).

LR = lethal radius (feet)

$$= 1000 * \left(\frac{3.48 + \text{SQRT}(12.1 + 3.3 * h)}{h} \right)^{2/3}$$

where h = target hardness in psi.

reference: Bennett, ASSESSING THE CAPABILITIES... (see bibliography)

EMT

EMT = equivalent megatonnage

= (Yield)^{2/3} for Yield ≤ 1 MT

= (Yield)^{1/2} for Yield > 1 MT

WEAPONS

WEAPONS = (# of ICBM RVs) + (# of SLBM RVs) + (# of bomber weapons)

TWT

TWT = ballistic missile throw weight

= (# ICBMs)*(throw weight per) + (# SLBM s)*(throw weight per)

(see Appendix E for throw weight attributed to each missile)

SWS

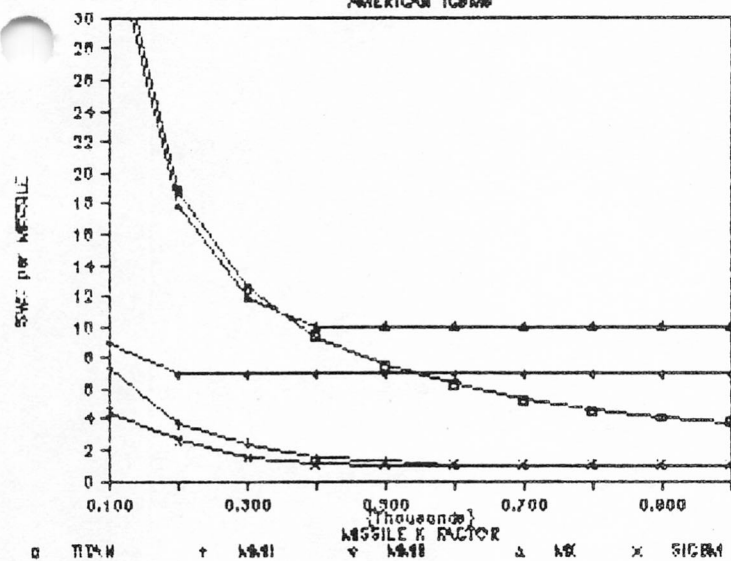
SWS = standard weapon stations

(see section 3.1.1 and Figure 3-2. See also Figure C-1, next page, which shows the number of standard weapon stations by K factor, for each of the strategic weapon systems on both sides.)

FIGURE C-1: STANDARD WEAPON STATIONS

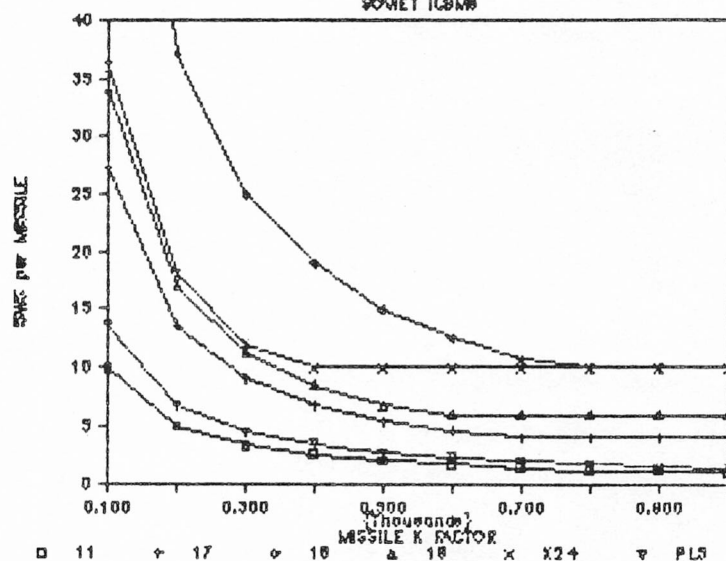
STD WEAPON STATIONS by K FACTOR

AMERICAN ICBM



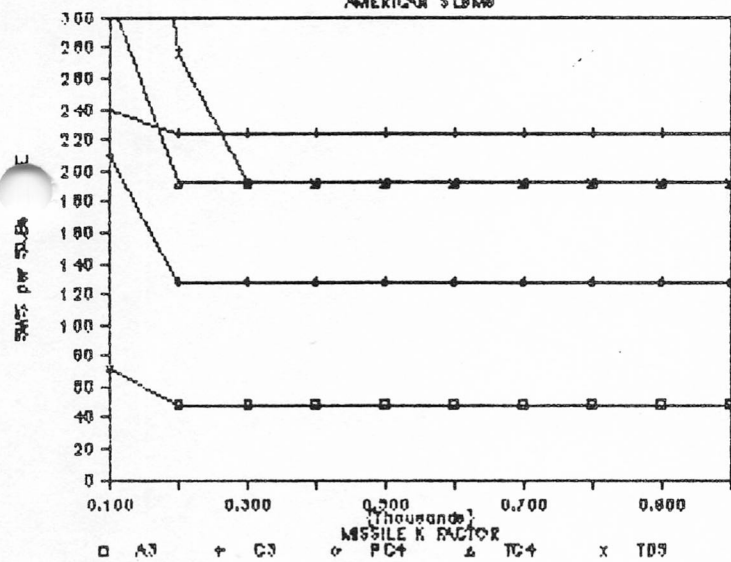
STD WEAPON STATIONS by K FACTOR

SOVIET ICBM



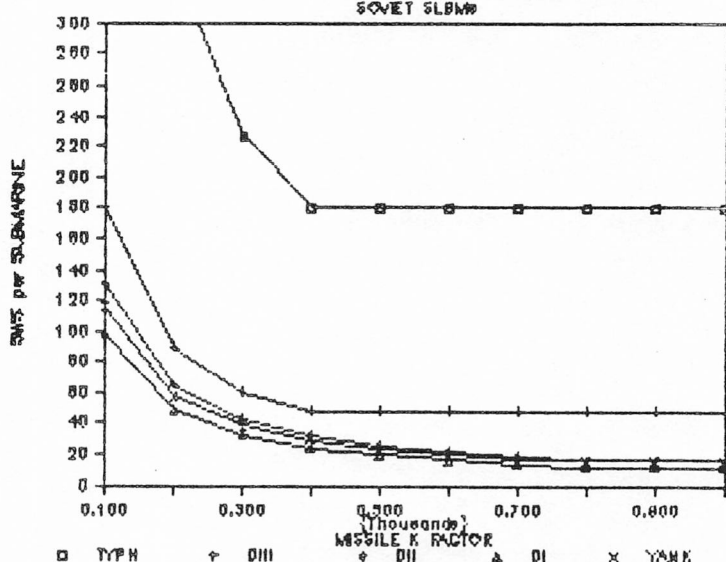
STD WEAPON STATIONS by K FACTOR

AMERICAN SLBM



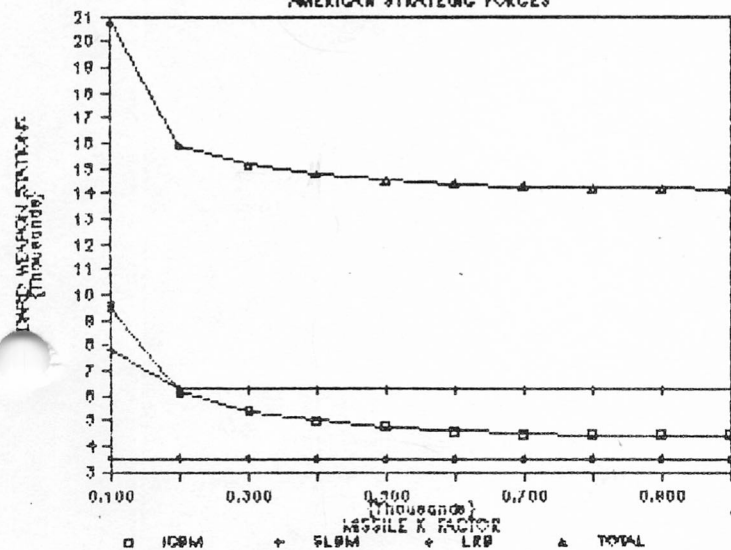
STD WEAPON STATIONS by K FACTOR

SOVIET SLBM



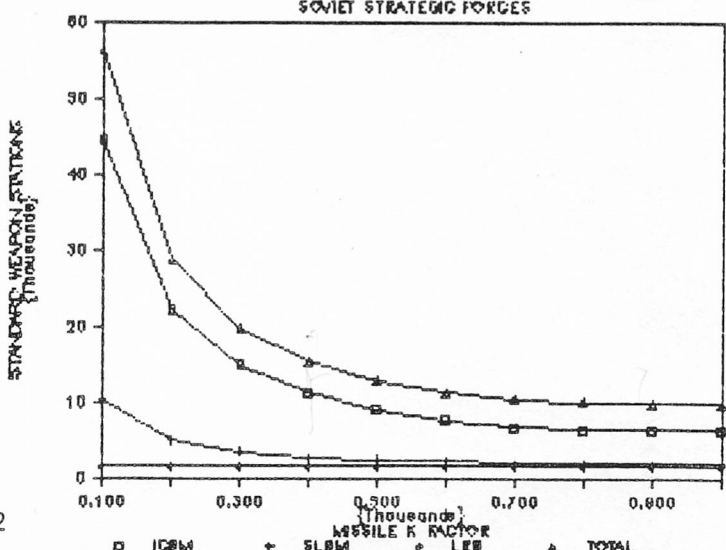
STD WEAPON STATIONS by K FACTOR

AMERICAN STRATEGIC FORCES



STD WEAPON STATIONS by K FACTOR

SOVIET STRATEGIC FORCES



APPENDIX D

DETAILS OF COUNTERFORCE EXCHANGE MODEL

This section describes the modeling process in greater detail. Figure D-1 is a block diagram of the U.S. first strike case of the counterforce exchange model. A similar sequence is used for the Soviet first strike, but is not described here. On subsequent pages are examples of Supercalc worksheets which correspond to the blocks.

USALERT

The input for the model comes from USAFILE and SOVFILE (Figure D-2), which are output from the build down worksheets. The command file USA1ST (Figure D-3) coordinates calculations for the American first strike case, calling worksheets USALERT, USSTRIKE, and USLEFT. It begins by first loading the worksheet USALERT, then data columns from USAFILE into the appropriate templates marked on the USALERT worksheet (Figure D-4). The number of alert warheads are determined by the alert rates shown in column G. The ICBM alert rates are constant. The SLBM alert rate is 0.6 for a first strike, but is 1.0 for retaliation. (The submarines which are not at sea at the beginning of an exchange are counted as destroyed in port. After subtracting these from the total available stock, the alert rate of the remaining forces is assumed to be 1.0). The output block for the United States, labelled "1984 ALRT UNITS", shows the number of alert warheads or standard weapon stations (depending on the entries in E7:E23) in each component of the ballistic missile force.

The Soviet input template lists ICBM forces read from SOVFILE for the appropriate year. The Soviet SSBN numbers are not used until worksheet USLEFT, in which they are reduced by the number of SSBNs in port at the beginning of the exchange. The second row in the SOVIET FORCES output template (F29:L29) lists numbers which identify the basing mode of each system. The numbers are used in worksheet USSTRIKE to retrieve appropriate overall probabilities of Kill (OPK's) of U.S. missiles against specific target types. The third row in the SOVIET FORCES output template (F30:L30) lists the 'nominal' price that must be paid to target a silo containing the designated Soviet missile type. For example, when using warhead counts, the prices are 2 per MIRVed target, and 1 per single warhead target. This format is useful for examining implications of different missile basing modes on the relative capabilities of the strategic forces. For example, it could be used to take account of the SS-X-25 small missile being deployed on hardened mobile carriers. It might take X SWS to achieve a damage expectancy of .9 against Y SS-X-25 mobile missiles deployed on Z square miles. The 'nominal' price X, in standard weapon stations, is listed in cell J30 on the USALERT worksheet. This work is in a preliminary stage, and the interim results are not presented in this paper.

USSTRIKE

Figure D-5 shows the worksheet which assigns warheads to targets. At the top (A1:S7) is a table of OPK values for American warheads against different target types, soft (5 psi), hardened (2000 psi), superhardened (N/A), and dispersed mobile (N/A). Cells A10:H14 contain the Soviet alert forces, as

read from 1984.CAL (this file is used at various steps in the processing to hold intermediate results). United States alert forces are read to B18:C30, and target assignment takes place in E17:R50. American missile warheads are assigned to targets in the order shown: MX first, then Trident D5, Midgetman, Minuteman III Mark 12A, and so on. They are assigned in rank order of OPK against hard targets. The most valuable Soviet targets are covered first; the rank is determined by the number of RV's per missile, and for single RV missiles, by OPK against hard targets. Assignment takes place according to 'nominal' prices, which in this example are 2 for a MIRVed ICBM and 1 for a single RV ICBM. The number of each target type destroyed is calculated by multiplying the number of U.S. warheads of each type assigned to each target type by the appropriate OPK, and summing the results. The numbers destroyed are shown in cells E35, H35, etc. The forces remaining to the U.S. are copied to A58:A76, and those surviving to the Soviet Union to B58:B69. The output template is written to 1984.CAL. This process is repeated for each year from 1984-2000.

USLEFT

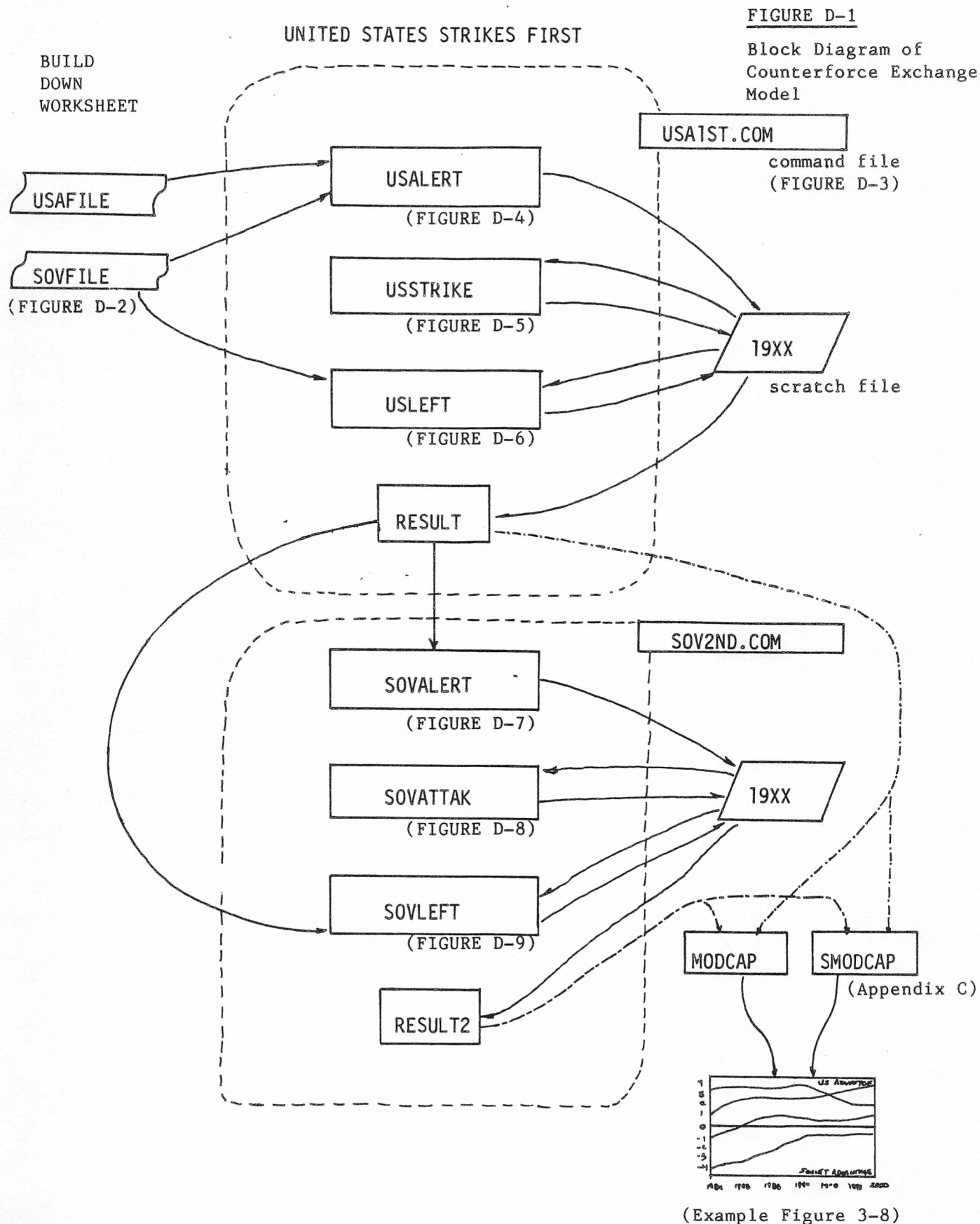
This worksheet, shown in Figure D-6, calculates the final tally of forces remaining to the United States, and those surviving to the Soviet Union. It takes account of the alert status of Soviet submarines and bombers, to determine how many are destroyed in port and on their air bases respectively. The conditional statements on the bottom of Figure D-6 show specifically how these calculations are done. The input and output templates are also indicated. This is the final step of the American first strike; the results for each year are collected in a file named RESULT, from which aggregate measures can be calculated for display.

RETALIATION

Soviet retaliation takes place through the worksheets SOVALERT, SOVATTAK, and SOVLEFT (Figures D-7, D-8, and D-9), which are the exact counterparts to USALERT, USSTRIKE, and USLEFT. In the case of retaliation, the input forces are read from RESULT rather than from SOVFILE and USAFILE. The process is controlled by the command file SOV2ND, not shown. The differences in calculation between first strike and retaliation are controlled by the 'key' cell, C1 in SOVALERT, and A1 in SOVLEFT.

TRENDS IN AGGREGATE MEASURES

The forces remaining to both sides are stored in RESULT2. RESULT and RESULT2 are then used as input to MODCAP and SMODCAP (see Appendix E for examples of these worksheets), in order to calculate aggregate measures of force capability. The resulting tables of aggregate measures are used to generate comparisons of alternative indices of capability after a counterforce exchange (Figure 3-8), and ratios of advantage plots (Figure 3-9).



NOTE: The xxxALRT, xxxSTRIKE, xxxLEFT sequence was broken into three parts because of limited computer memory capacity. These functions could be combined in a larger machine.

FIGURE D-2

USAFILE AND SOVFILE, INPUTS TO COUNTERFORCE MODEL

EXEMPLARY DOUBLE BUILD DOWN, UNITED STATES FORCES (USAFILE)																		USAFILE & SOVFILE	
SYSTEM	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000		
ITAN	34	29	20	10	0	0	0	0	0	0	0	0	0	0	0	0	0		
MM I1	450	349	226	166	100	100	100	100	100	100	100	100	100	100	100	100	100		
MM MK 12	250	250	193	127	73	0	0	0	0	0	0	0	0	0	0	0	0		
MM MK12Ai	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300		
MM MK12Ao	0	0	0	0	0	-17	-54	-90	-144	-182	-185	-188	-200	-200	-200	-200	-200		
MX in	0	0	10	20	30	40	50	60	70	80	90	100	100	100	100	100	100		
MX out	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
MIDGET in	0	0	0	0	0	0	0	0	20	100	200	300	400	528	528	528	528		
MIDGETout	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
POLA3	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
POSC3	19	16	13	11	10	8	5	2	0	0	0	0	0	0	0	0	0		
POSC4	12	12	12	12	12	12	12	12	11	9	6	3	1	0	0	0	0		
TRIC4 in	3	5	7	8	8	8	8	8	8	8	8	8	8	8	8	8	8		
TRIC4 out	0	0	0	0	0	0	0	0	0	-1	-2	-3	-4	-5	-6	-7	-8		
TRID5 in	0	0	0	0	0	1	2	3	4	6	8	10	12	13	14	15	16		
TRID5 out	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
FB-111	56	55	55	50	50	50	50	50	50	0	0	0	0	0	0	0	0		
B-52G	61	55	40	10	0	0	0	0	0	0	0	0	0	0	0	0	0		
B-52H	90	80	60	50	40	22	9	6	3	1	0	1	1	1	1	1	1		
B-52 CMCI	90	100	120	120	120	134	144	144	144	144	144	144	144	144	144	144	144		
B-52 CMCo	0	0	0	0	0	0	0	0	0	-17	-51	-87	-113	-113	-113	-113	-113		
B-1B peni	0	1	17	59	80	90	93	102	106	106	106	106	106	106	106	106	106		
B-1B peno	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
B-1B CMC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
STEALTH	0	0	0	0	0	0	0	0	15	47	78	111	120	120	120	120	120		
EXEMPLARY DOUBLE BUILD DOWN, SOVIET FORCES (SOVFILE)																			
SYSTEM	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000		
SS-11	570	400	230	60	0	0	0	0	0	0	0	0	0	0	0	0	0		
SS-13	60	25	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
SS-17	150	130	105	77	20	1	0	0	0	0	0	0	0	0	0	0	0		
SS-18 one	24	24	24	24	24	24	12	12	7	0	0	0	0	0	0	0	0		
mirv in	284	284	284	284	284	284	284	284	284	284	284	284	284	284	284	284	284		
mirv out	0	0	0	0	0	-22	-41	-75	-101	-102	-140	-202	-255	-255	-255	-255	-255		
SS-19 mir	330	330	330	330	330	330	330	330	330	330	330	330	330	330	330	330	330		
mirv out	0	0	0	0	0	0	-27	-27	-46	-47	-55	-55	-75	-75	-75	-75	-75		
SSX24 MXs	0	0	0	0	0	0	0	0	0	0	20	77	135	135	135	135	135		
PL-5 mobil	0	0	0	10	30	70	100	100	100	100	135	175	213	213	213	213	213		
YANKEE	27	22	17	12	6	0	0	0	0	0	0	0	0	0	0	0	0		
DELTA I	18	17	16	15	14	12	9	6	6	6	6	6	5	5	5	5	5		
DELTA II	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4		
DELTA III	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11		
DELTA IIII	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
TYPHOON	4	4	4	4	4	4	4	4	4	4	5	5	5	5	5	5	5		
BEAR	100	100	89	66	33	0	0	0	0	0	0	0	0	0	0	0	0		
BISON	45	45	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
BACKFIRE	70	96	120	140	150	150	150	150	150	85	47	40	40	40	40	40	40		
BLACKJACK	0	0	20	40	60	83	100	111	125	125	125	125	125	125	125	125	125		

FIGURE D-3

Exemplary command
file for counter-
force exchange
model USA1ST.COM

```

type h:usa1st.com
/LB:USALERT,A
=h1
.75
/LB:USAFIL, PB2:B20, A5
/LB:SOVFILE, PB2:B13, L5
/SB:1984, OPVA26:L38
/LB:USAFIL, PC2:C20, A5
/LB:SOVFILE, PC2:C13, L5
/SB:1985, OPVA26:L38
/LB:USAFIL, PD2:D20, A5
/LB:SOVFILE, PD2:D13, L5
/SB:1986, OPVA26:L38
/LB:USAFIL, PE2:E20, A5
/LB:SOVFILE, PE2:E13, L5
/SB:1987, OPVA26:L38
/LB:USAFIL, PF2:F20, A5
/LB:SOVFILE, PF2:F13, L5
/SB:1988, OPVA26:L38
/LB:USAFIL, PG2:G20, A5
/LB:SOVFILE, PG2:G13, L5
/SB:1989, OPVA26:L38
/LB:USAFIL, PH2:H20, A5
/LB:SOVFILE, PH2:H13, L5
/SB:1990, OPVA26:L38
/LB:USAFIL, PI2:I20, A5
/LB:SOVFILE, PI2:I13, L5
/SB:1991, OPVA26:L38
/LB:USAFIL, PJ2:J20, A5
/LB:SOVFILE, PJ2:J13, L5
/SB:1992, OPVA26:L38
/LB:USAFIL, PK2:K20, A5
/LB:SOVFILE, PK2:K13, L5
/SB:1993, OPVA26:L38
/LB:USAFIL, PL2:L20, A5
/LB:SOVFILE, PL2:L13, L5
/SB:1994, OPVA26:L38
/LB:USAFIL, PM2:M20, A5
/LB:SOVFILE, PM2:M13, L5
/SB:1995, OPVA26:L38
/LB:USAFIL, PN2:N20, A5
/LB:SOVFILE, PN2:N13, L5
/SB:1996, OPVA26:L38
/LB:USAFIL, PO2:O20, A5
/LB:SOVFILE, PO2:O13, L5
/SB:1997, OPVA26:L38
/LB:USAFIL, PP2:P20, A5
/LB:SOVFILE, PP2:P13, L5
/SB:1998, OPVA26:L38
/LB:USAFIL, PQ2:Q20, A5
/LB:SOVFILE, PQ2:Q13, L5
/SB:1999, OPVA26:L38
/LB:USAFIL, PR2:R20, A5
/LB:SOVFILE, PR2:R13, L5
/SB:2000, OPVA26:L38
/ZY
/LB:USSTRIKE,A
/LB:1984, PB26:C38, B18
/LB:1984, PE26:L30, A10
/SB:1984, OPVA58:B76
/LB:1985, PB26:C38, B18
/LB:1985, PE26:L30, A10
/SB:1985, OPVA58:B76
/LB:1986, PB26:C38, B18
/LB:1986, PE26:L30, A10
/SB:1986, OPVA58:B76
/LB:1987, PB26:C38, B18
/LB:1987, PE26:L30, A10
/SB:1987, OPVA58:B76
/LB:1988, PB26:C38, B18
/LB:1988, PE26:L30, A10
/SB:1988, OPVA58:B76
/LB:1989, PB26:C38, B18
/LB:1989, PE26:L30, A10
/SB:1989, OPVA58:B76
/LB:1990, PB26:C38, B18
/LB:1990, PE26:L30, A10
/SB:1990, OPVA58:B76
/LB:1991, PB26:C38, B18
/LB:1991, PE26:L30, A10
/SB:1991, OPVA58:B76
/LB:1992, PB26:C38, B18
/LB:1992, PE26:L30, A10
/SB:1992, OPVA58:B76
/LB:1993, PB26:C38, B18
/LB:1993, PE26:L30, A10
/SB:1993, OPVA58:B76
/LB:1994, PB26:C38, B18
/LB:1994, PE26:L30, A10
/SB:1994, OPVA58:B76
/LB:1995, PB26:C38, B18
/LB:1995, PE26:L30, A10
/SB:1995, OPVA58:B76
/LB:1996, PB26:C38, B18
/LB:1996, PE26:L30, A10
/SB:1996, OPVA58:B76
/LB:1997, PB26:C38, B18
/LB:1997, PE26:L30, A10
/SB:1997, OPVA58:B76
/LB:1998, PB26:C38, B18
/LB:1998, PE26:L30, A10
/SB:1998, OPVA58:B76
/LB:1999, PB26:C38, B18
/LB:1999, PE26:L30, A10
/SB:1999, OPVA58:B76
/LB:2000, PB26:C38, B18
/LB:2000, PE26:L30, A10
/SB:2000, OPVA58:B76
/ZY
/LB:USLEFT,A
=a5
.75
=a6
.95
=a7
.85
=a9
.75
=a10
.95
=a11
.85
=A1
1
=D14
/LB:SOVFILE, PB2:B25, B16
/RB16:B39, C16
/LB:USAFIL, PB2:B30, A16
/LB:1984, PA58:B76, A16
/SB:1984, OPVD14:G44
/LB:SOVFILE, PC2:C25, B16
/RB16:B39, C16
/LB:USAFIL, PC2:C30, A16
/LB:1985, PA58:B76, A16
/SB:1985, OPVD14:G44
/LB:SOVFILE, PD2:D25, B16
/RB16:B39, C16
/LB:USAFIL, PD2:D30, A16
/LB:1986, PA58:B76, A16
/SB:1986, OPVD14:G44
/LB:SOVFILE, PE2:E25, B16
/RB16:B39, C16
/LB:USAFIL, PE2:E30, A16
/LB:1987, PA58:B76, A16
/SB:1987, OPVD14:G44
/LB:SOVFILE, PF2:F25, B16
/RB16:B39, C16
/LB:USAFIL, PF2:F30, A16
/LB:1988, PA58:B76, A16
/SB:1988, OPVD14:G44
/LB:SOVFILE, PG2:G25, B16
/RB16:B39, C16
/LB:USAFIL, PG2:G30, A16
/LB:1989, PA58:B76, A16
/SB:1989, OPVD14:G44
/LB:SOVFILE, PH2:H25, B16
/RB16:B39, C16
/LB:USAFIL, PH2:H30, A16
/LB:1990, PA58:B76, A16
/SB:1990, OPVD14:G44
/LB:SOVFILE, PI2:I25, B16
/RB16:B39, C16
/LB:USAFIL, PI2:I30, A16
/LB:1991, PA58:B76, A16
/SB:1991, OPVD14:G44
/LB:SOVFILE, PJ2:J25, B16
/RB16:B39, C16
/LB:USAFIL, PJ2:J30, A16
/LB:1992, PA58:B76, A16
/SB:1992, OPVD14:G44
/LB:SOVFILE, PK2:K25, B16
/RB16:B39, C16
/LB:USAFIL, PK2:K30, A16
/LB:1993, PA58:B76, A16
/SB:1993, OPVD14:G44
/LB:SOVFILE, PL2:L25, B16
/RB16:B39, C16
/LB:USAFIL, PL2:L30, A16
/LB:1994, PA58:B76, A16
/SB:1994, OPVD14:G44
/LB:SOVFILE, PM2:M25, B16
/RB16:B39, C16
/LB:USAFIL, PM2:M30, A16
/LB:1995, PA58:B76, A16
/SB:1995, OPVD14:G44
/LB:SOVFILE, PN2:N25, B16
/RB16:B39, C16
/LB:USAFIL, PN2:N30, A16
/LB:1996, PA58:B76, A16
/SB:1996, OPVD14:G44
/LB:SOVFILE, PO2:O25, B16
/RB16:B39, C16
/LB:USAFIL, PO2:O30, A16
/LB:1997, PA58:B76, A16
/SB:1997, OPVD14:G44
/LB:SOVFILE, PP2:P25, B16
/RB16:B39, C16
/LB:USAFIL, PP2:P30, A16
/LB:1998, PA58:B76, A16
/SB:1998, OPVD14:G44
/LB:SOVFILE, PQ2:Q25, B16
/RB16:B39, C16
/LB:USAFIL, PQ2:Q30, A16
/LB:1999, PA58:B76, A16
/SB:1999, OPVD14:G44
/LB:SOVFILE, PR2:R25, B16
/RB16:B39, C16
/LB:USAFIL, PR2:R30, A16
/LB:2000, PA58:B76, A16
/SB:2000, OPVD14:G44
/ZY
/FG5
/FCA, 10
/LB:USLEFT, PD18:D44, A4

```


FIGURE D-4

Example of
USALERT

	A	B	C	D	E	F	G	H	I	J	K	L	M
1: USA	1	'1' = First strike								SOVIET			
2: INPUT		'0' = Retaliation		sub alert						INPUT			
3: TEMPLATE	UNITS								TEMPLATE				
4: *****	PLAT-	PER	ALRT	ALRT	ALRT	*****							
5: 1984	SYSTEM FORMS SNDV	SNDV	WHDS	RATE	LNCR	WHDS	SYSTEM	1984					
6: 34	TITAN	34	34	1	34	.85	28	28					
8: 450	MM II	450	450	1	450	.9	405	405					
9: 250	Mk 12	250	250	3	750	.98	245	735					
10: 300	Mk12Ai	300	300										
11: 0	Mk12Ao	0	0	3	900	.98	294	882					
12: 0	MX in	0	0										
13: 0	MX out	0	0	10	0	.98	0	0					
14: 0	MIDGi	0	0										
15: 0	MIDGo	0	0	1	0	.9	0	0					
16: 2	POLA3	2	32	3	96	.6	19	57					
18: 19	POSC3	19	304	10	3040	.6	182	1820					
19: 12	POSC4	12	192	8	1536	.6	115	920					
20: 3	TC4i	3	72										
21: 0	TC4o	0	0	8	576	.6	43	344					
22: 0	TD5i	0	0										
23: 0	TD5o	0	0	8	0	.6	0	0					

INPUT TEMPLATE from SOVFILE

INPUT TEMPLATE from USAFILE

SOVIET FORCES output template

1984	SSX24	SS-18	SS-19	SS-17	SSX25	SS-11	SS-13
sndv's	0	308	330	150	0	570	60
basing	2	2	2	2	2	2	2
price	2	2	2	2	1	1	1

USALERT

OUTPUT TEMPLATE FOR SOVIET ALERT FORCES. WRITTEN TO 1984.CAL (SCRATCH FILE). REAPPEARS IN WORKSHEET USSTRIKE AT CELLS (A10: H14).

OUTPUT TEMPLATE FOR U.S. ALERT FORCES. WRITTEN TO 1984.CAL (SCRATCH FILE). REAPPEARS IN WORKSHEET USSTRIKE AT CELLS (B18: C30).

1 A B C D E F G H I J K L M N O P Q R S T

1 PK TABLE

	MX	TRID5	MIDG	12A	12	MM II	TRIC4	POSC4	POSC3
4.5 PSI	1 .85	1 .85	1 .8	1 .8	1 .8	1 .8	1 .8	1 .8	1 .8
2KPSI	2 .976	2 .977	2 .8	2 .736	2 .589	2 .191	2 .34	2 .34	2 .88
SHARD	3 N/A	3 N/A	3 N/A	3 N/A	3 N/A	3 N/A	3 N/A	3 N/A	3 N/A
BARAGE	4 N/A	4 N/A	4 N/A	4 N/A	4 N/A	4 N/A	4 N/A	4 N/A	4 N/A

FIGURE D-5

Example of
USSTRIKE

9 SOVIET FORCES input template

1984	SSX24	SS-18	SS-19	SS-17	SSX25	SS-11	SS-13	LCC
sndv's	0	308	330	150	0	570	60	141
basing	2	2	2	2	2	2	2	1
price	2	2	2	2	1	1	1	

INPUT TEMPLATE from USALERT via 1984.

16 TARGET ASSIGNMENTS

	UNITS 1984	basing	SSX24	SS18	SS19	SS17	SSX25
PER	ALRT	price	2	2	2	2	2
TYPE	SNDV	UNITS	LEFT	LEFT	LEFT	LEFT	LEFT
MX	10	0	0	0	0	0	0
TRID5	8	0	0	0	0	0	0
MIDGET	1	0	0	0	0	0	0
12A	3	882	0	308	266	0	0
12	3	735	0	0	735	2	197
MM II	1	405	0	0	405	1	0
TRIDC4	8	344	0	0	344	2	0
POSC4	8	920	0	0	920	2	0
POSC3	10	1820	0	0	1820	2	0

INPUT TEMPLATE from
USALERT via 1984.

NUMBER DESTROYED

0	226	213	88	0
0	0	0	0	0
0	226	213	88	0

	ALRT	UNITS	SS11	SS13	LCC	PORT	BMBR
LEFT	LEFT	1	1	1	1	1	1
TYPE	LEFT	570	60	141	5	15	OVER
MX	0	1	0	0	0	0	0
TRID5	0	1	0	0	0	0	0
MIDGET	0	1	0	0	0	0	0
12A	0	1	0	0	0	0	0
12	41	1	41	0	0	0	0
MM II	405	1	405	0	0	0	0
TRIDC4	344	1	124	220	1	60	160
POSC4	920	1	0	920	1	0	920
POSC3	1820	1	0	1820	1	0	1820

NUMBER DESTROYED

24	0			
119	20			
143	20			

1984	1984	USA	USSR
427			SS-11
40	MM II		SS-13
62	Mk 12		SS-17
0	12Ai		SS18s
0	32	12Ao	SS18mi
0	MX i		SS18mo
0	117	MX o	SS-19i
0	0	MIDGi	SS-19o
0	0	MIDGo	SSX24
0	0		SSX25
11.38		POSC3	
7.13		POSC4	
0		TC4i	
0		TC4o	
0		TD5i	
0		TD5o	

OUTPUT TEMPLATE: US FORCES REMAINING,
SOVIET FORCES SURVIVING,
to 1984.

USSTRIKE

FIGURE D-6

Example of
USLEFT

1 A B C D E F G H I J K
2 1 = First Strike
3 0 = Retaliation
4 .6 US subs at sea
5 .35 US bombers alert
6 .95 US alert bombers survive 1st strike
7 .8 US bomber max alert w/o strat warning
8
9 .4 USSR subs at sea
10 .1 USSR bombers alert
11 .95 USSR alert bombers survive 1st strike
12 .8 USSR bomber max alert w/o strat warning
13

INPUT TEMPLATE: US FORCES REMAINING, SOVIET FORCES SURVIVING,
FROM USSRIKE VIA 1984.

	NOM	ORG	USA	USSR
	USSR	USSR	OUT	OUT
	1984	1984	1984	1984
18	0	427	570 TITAN	0 SS-11 427
19	0	40	60 MM 11	0 SS-13 40
20	0	62	150 Mk 12	0 SS-17 62
21	0	0	24 Mk12Ai	0 SS18s 0
22	0	82	284 Mk12Ao	0 SS18mi 82
23	0	0	0 MX in	0 SS18mo 0
24	0	117	330 MX out	0 SS-19i 117
25	0	0	0 MIDGi	0 SS-19o 0
26	0	0	0 MIDGo	0 SSX24 0
27	0	0	0	0 SSX25 0
28	2		POLA3	2
29	11.38	27	27 POSC3	11.38 YANKEE 10
30	7.13	18	18 POSC4	7.13 D I 7
31	3	4	4 TC4i	3 D II 1
32	0	11	11 TC4o	0 D IIIi 4
33	0	0	0 TD5i	0 D IIIo 0
34	0	4	4 TD5o	0 TYPH 1
35				
36	56	100	100 FB-111	56 BEAR 9
37	61	45	45 B-52G	61 BISON 4
38	90	70	70 B-52H	90 BCKFIR 6
39	90	0	0 52CMCi	90 BLKJCK 0
40	0		0 52CMCo	
41	0		0 B-18pi	
42	0		0 B-18po	
43	0		0 B-18CM	
44	0		0 STEAL	

USLEFT

OUTPUT TEMPLATES: TO RESULT, VIA 1984

INPUT
TEMPLATE
FROM
CONF FILE

1 A B C D E F G H I J K L M N O

	NOM	ORG	USA	USSR
	USSR	USSR	OUT	OUT
	1984	1984	A16	B16
18	0	427	570 TITAN A18	SS-11 B18
19	0	40	60 MM 11 A19	SS-13 B19
20	0	62	150 Mk 12 A20	SS-17 B20
21	0	0	24 Mk12Ai A21	SS18s B21
22	0	82	284 Mk12Ao A22	SS18mi B22
23	0	0	0 MX in A23	SS18mo B23
24	0	117	330 MX out A24	SS-19i B24
25	0	0	0 MIDGi A25	SS-19o B25
26	0	0	0 MIDGo A26	SSX24 B26
27	0	0	0	SSX25 B27
28	2		POLA3 A28	
29	11.38	27	27 POSC3 A29	YANKEE IF(A1=1,INT(B29*A9),B29-INT(C29*(1-A9)))
30	7.13	18	18 POSC4 A30	D I IF(A1=1,INT(B30*A9),B30-INT(C30*(1-A9)))
31	3	4	4 TC4i A31	D II IF(A1=1,INT(B31*A9),B31-INT(C31*(1-A9)))
32	0	11	11 TC4o A32	D IIIi IF(A1=1,INT(B32*A9),B32-INT(C32*(1-A9)))
33	0	0	0 TD5i A33	D IIIo 0
34	0	4	4 TD5o A34	TYPH IF(A1=1,INT(B34*A9),B34-INT(C34*(1-A9)))
35				
36	56	100	100 FB-111 A36	BEAR INT(IF(A1=1,B36*A10*A11,B36*A12))
37	61	45	45 B-52G A37	BISON INT(IF(A1=1,B37*A10*A11,B37*A12))
38	90	70	70 B-52H A38	BCKFIR INT(IF(A1=1,B38*A10*A11,B38*A12))
39	90	0	0 52CMCi A39	BLKJCK INT(IF(A1=1,B39*A10*A11,B39*A12))
40	0		0 52CMCo A40	
41	0		0 B-18pi A41	
42	0		0 B-18po A42	
43	0		0 B-18CM A43	
44	0		0 STEAL A44	

FORMULA VERSION OF USLEFT

USLEFT

FIGURE D-7

Example of
SOVALERT

	A	B	C	D	E	F	G	H	I	J	K	L	M
1: USSR													USA
2: INPUT													INPUT
3: TEMPLATE													TEMPLATE
4: *****													*****
5: 1984	SYSTEM	FORMS	SNDV	SNDV	WHDS	RATE	LNCR	WHDS				SYSTEM	1984
6: -----													-----
7: 427	SS-11	427	427	1	427	.85	362	362				TITAN	0
8: 40	SS-13	40	40	1	40	.85	34	34				MM II	0
9: 62	SS-17	62	62	4	248	.85	52	208				Mk 12	0
10: 0	SS18s	0	0									Mk12Ai	0
11: 82	SS18mi	82	82									Mk12Ao	0
12: 0	SS18mo	0	0	10	820	.85	69	690				MX in	0
13: 117	SS-19i	117	117									MX out	0
14: 0	SS-19o	0	0	6	702	.85	99	594				MIDGi	0
15: 0	SSX24	0	0	10	0	.85	0	0				MIDGo	0
16: 0	SSX25	0	0	1	0	.85	0	0					
17: -----													
18: 10	YANKEE	10	160	1	160	1	160	160					
19: 7	D I	7	84	1	84	1	84	84					
20: 1	D II	1	16	1	16	1	16	16					
21: 4	D IIIi	4	64										
22: 0	D IIIo	0	0	3	192	1	64	192					
23: 1	TYPH	1	20	9	180	1	20	180					
24: -----													

INPUT TEMPLATE FROM RESULT

25: UNITS	1984
26: PER	ALRT
27: TYPE	SNDV UNITS
28: -----	-----
30: SSX24	10 0
31: SS-19	6 594
32: SS-18	10 690
33: SSX25	1 0
34: SS-17	4 208
35: TYPH	9 180
36: DIII	3 192
37: DII,Y	1 176
38: DI	1 84
39: SS-11	1 362
40: SS-13	1 34

AMERICAN FORCES output template

1984	MX	12A	12	MM II	MIDG
-----	-----	-----	-----	-----	-----
sndv's	0	0	0	0	0
basing	2	2	2	2	2
price	2	2	2	2	1

OUTPUT TEMPLATE FOR U.S. ALERT FORCES REMAINING.

SOVALERT

OUTPUT TEMPLATE FOR SOVIET ALERT FORCES.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
1:FK TABLE																				
2:																				
3:																				
4:																				
5:PSI	1	.8	1	.75	1	.75	1	.8	1	.75	1	.7	1	.7	1	.7	1	.7	1	.7
6:2KPSI	2	.886	2	.668	2	.668	2	.662	2	.231	2	.124	2	.124	2	.062	2	.062	2	.062
7:SHARD	3	N/A	3	N/A	3	N/A	3	N/A	3	N/A	3	N/A	3	N/A	3	N/A	3	N/A	3	N/A
8:BARAGE	4	N/A	4	N/A	4	N/A	4	N/A	4	N/A	4	N/A	4	N/A	4	N/A	4	N/A	4	N/A

FIGURE D-8

Example of
SOVATTAK

9:AMERICAN FORCES input template INPUT TEMPLATE FROM SOVALERT VIA 1984.

1984	MX	12A	12	MM II	MIDG	LCC	SS-11	SS-13
sndv's	0	0	0	0	0	0	1 .699	1 .707
basing	2	2	2	2	2	1	2 .033	2 .015
price	2	2	2	2	1		3 N/A	3 N/A
							4 N/A	4 N/A

16:TARGET ASSIGNMENTS

	UNITS 1984	basing	MX	UNITS	12A	12	MM II	MIDG
PER	ALRT	price	2	2 LEFT	2	2 LEFT	2 LEFT	2 LEFT
SNDV	UNITS	silos	0 OVER	0 OVER	0 OVER	0 OVER	0 OVER	0 OVER
22:SSX24	10	0	2	0	0	2	0	0
23:SS-19	6	594	2	0	594	2	0	594
24:SS-18	10	690	2	0	690	2	0	690
25:SSX25	1	0	1	0	0	1	0	0
26:SS-17	4	208	2	0	208	2	0	208
27:TYPH	9	180	2	0	180	2	0	180
28:DIII	3	192	2	0	192	2	0	192
29:DII,Y	1	176	1	0	176	1	0	176
30:DI	1	84	1	0	84	1	0	84
31:SS-11	1	362	1	0	362	1	0	362
32:SS-13	1	34	1	0	34	1	0	34

INPUT TEMPLATE FROM
SOVALERT VIA 1984.

NUMBER DESTROYED

	ALRT	LCC	PORT	BMBR
UNITS	1 LEFT	1 LEFT	1 LEFT	1 LEFT
LEFT	0 OVER	0 OVER	0 OVER	0 OVER
45:SSX24	0	1	0	0
46:SS-19	594	1	0	57
47:SS-18	690	1	0	690
48:SSX25	0	1	0	0
49:SS-17	208	1	0	208
50:TYPH	180	1	0	180
51:DIII	192	1	0	192
52:DII,Y	176	1	0	176
53:DI	84	1	0	84
54:SS-11	362	1	0	362
55:SS-13	34	1	0	34

OUTPUT TEMPLATE: SOVIET FORCES REMAINING,
U.S. FORCES SURVIVING,
to AB4.

SOVATTAK

0	1984	USSR	USA
362	SS-11		
34	SS-13	MM II	
52	SS-17	Mk 12	
0	SS18s	Mk12Ai	
69	SS18mi	Mk12Ao	
0	SS18mo	MX in	
87	SS-19i	MX out	
0	SS-19o	MIDGi	
0	SSX24	MIDGo	
0	SSX25		
0	YANKEE		
7.00	D I		
11.00	D II		
4.00	D IIIi		
0	D IIIo		
1.00	TYPH		

FIGURE D-9

Example of

SOVLEFT

1 A B C D E F G H I J K

1 0 '1' = First Strike
2 0 '0' = Retaliation

3
4 USSR subs at sea
5 USSR bombers alert
6 .95 USSR alert bombers survive 1st strike
7 .8 USSR bomber max alert w/o strat warning
8
9 .6 US subs at sea
10 .35 US bombers alert
11 .95 US alert bombers survive 1st strike
12 .8 US bomber max alert w/o strat warning
13

USSR	NOM	ORG	USSR	USA
1984	1984	1984	OUT	OUT
1984	1984	1984	1984	1984
362	0	34	SS-11	362 TITAN
34	0	450	SS-13	34 MM 11
52	0	250	SS-17	52 Mk 12
0	0	300	SS18s	0 Mk12Ai
69	0	0	SS18mi	69 Mk12Ao
0	0	0	SS18mo	0 MX in
87	0	0	SS-19i	87 MX out
0	0	0	SS-19o	0 MIDGi
0	0	0	SSX24	0 MIDGo
0	0	0	SSX25	0
2	2	2	POLA3	2
0	11.38	19	YANKEE	0 POSC3 4.38
7	7.13	12	D I	7 POSC4 3.13
11	3	3	D II	11 TC4i 2
4	0	0	D IIIi	4 TC4o 0
0	0	0	D IIIo	0 TD5i 0
1	0	0	TYPH	1 TD5o 0
9	56	56	BEAR	9 FB-111 44
4	61	61	BISON	4 B-52G 48
6	90	90	BCKFIR	6 B-52H 72
0	90	90	BLKJCK	0 52CMCi 72
0	0	0		52CMCo 0
0	0	0		B-1Bpi 0
0	0	0		B-1Bpo 0
0	0	0		B-1BCM 0
0	0	0		STEAL 0

INPUT TEMPLATE: SOVIET FORCES REMAINING, U.S. FORCES SURVIVING,
FROM SOVIETAK, VIA 1984.

SOVLEFT

OUTPUT TEMPLATES: TO RESULTS, VIA 1984

INPUT TEMPLATE
FROM RESULT

1 A B C D E F G H I J K L M N O

USSR	NOM	ORG	USSR	USA
1984	1984	1984	OUT	OUT
1984	1984	1984	A16	B16
362	0	34	SS-11 A18	TITAN B18
34	0	450	SS-13 A19	MM 11 B19
52	0	250	SS-17 A20	Mk 12 B20
0	0	300	SS18s A21	Mk12Ai B21
69	0	0	SS18mi A22	Mk12Ao B22
0	0	0	SS18mo A23	MX in B23
87	0	0	SS-19i A24	MX out B24
0	0	0	SS-19o A25	MIDGi B25
0	0	0	SSX24 A26	MIDGo B26
0	0	0	SSX25 A27	
2	2	2	POLA3	IF(A1=1,INT(B28*A9),B28-INT(C28*(1-A9)))
0	11.38	19	YANKEE A29	POSC3 IF(A1=1,INT(B29*A9),B29-INT(C29*(1-A9)))
7	7.13	12	D I A30	POSC4 IF(A1=1,INT(B30*A9),B30-INT(C30*(1-A9)))
11	3	3	D II A31	TC4i IF(A1=1,INT(B31*A9),B31-INT((C31+C32)*(1-A9)))
4	0	0	D IIIi A32	TC4o 0
0	0	0	D IIIo A33	TD5i IF(A1=1,INT(B33*A9),B33-INT((C33+C34)*(1-A9)))
1	0	0	TYPH A34	TD5o 0
9	56	56	BEAR A36	FB-111 INT(IF(A1=1,B36*A10*A11,B36*A12))
4	61	61	BISON A37	B-52G INT(IF(A1=1,B37*A10*A11,B37*A12))
6	90	90	BCKFIR A38	B-52H INT(IF(A1=1,B38*A10*A11,B38*A12))
0	90	90	BLKJCK A39	52CMCi INT(IF(A1=1,(B39*B40)*A10*A11,(B39+B40)*A12))
0	0	0		52CMCo 0
0	0	0		B-1Bpi INT(IF(A1=1,(B41+B42)*A10*A11,(B41+B42)*A12))
0	0	0		B-1Bpo 0
0	0	0		B-1BCM INT(IF(A1=1,B43*A10*A11,B43*A12))
0	0	0		STEAL INT(IF(A1=1,B44*A10*A11,B44*A12))

FORMULA VERSION OF SOVLEFT

SOVLEFT

APPENDIX E

ASSUMPTIONS ABOUT FORCE CAPABILITIES

Figure E-1 contains examples of the MODCAP and SMODCAP worksheets, which are used for calculations of aggregate measures of force capability. Input templates are also marked. The assumed values for reliability rate, circular error probable, and yield are listed for all strategic nuclear systems on both sides. These apply to all cases discussed in the text. Note that numbers in the AVLB column (column G) do not correspond exactly to the alert rate presented in Appendix D -- the value in Appendix D is the one actually used in the model. The baseline single and double build downs in the text were evaluating assuming:

1. All missile silos on both sides are hardened to an average of 2000 psi.
2. Day to day alert rates apply:
 - 60 % of U.S. submarines at sea (all alert).
 - 35 % of U.S. bombers alert.
 - 40 % of Soviet submarines at sea (all alert).
 - 10 % of Soviet bombers alert.

Figure E-1 also shows the yield, EMT, ballistic missile throw weight, CMP, ECMP, 2000 psi kills, and standard weapon stations per weapon for all strategic systems. The aggregates across the forces are calculated in columns S through Z -- the last several columns are not shown. Also not shown are calculations of the numbers of launchers by SALT II categories.

FIGURE E-1: Examples of MODCAP and SMODCAP

USSR FORCES: AGGREGATE MEASURES											AGGREGATES PER WHD/VEHICLE											AGGREGATES PER SYSTEM										
	PLAT- FORMS 1984	SNDV PER PLTF	SNDV	WHDS PER SNDV	WHDS	AVLB	REL/ PEN	CEP nMI	YLD (MT)	EMT	THWT/ PYLD Kib	CMP	ECMP	2000 PSI	KILLS	SWS	YLD (MT)	EMT	THWT/ PYLD (Kib)	MIRV THRWT (Kib)	CMP (100)	ECMP (100)										
9: TITAN	34	1	34	1	34	.85	.75	.80	9	3.00	8.28	7	4.95	.12	7.5		306	102	281		2	2										
10: MM II	450	1	450	1	450	.9	.8	.34	1.2	1.10	1.63	10	7.59	.18	1.48		540	493	731		44	34										
11: MM Mk 12	250	1	250	3	750	.98	.8	.12	.17	.55	1.98	21	15.9	.35	7		128	416	494		160	119										
12: MM Mk12A in	300	1	300	3	900	.98	.8	.12	.335	.69	1.98	33	23.9	.47	7		302	625	593	593	301	215										
13: MM Mk12A out	0	1	0	3	0	.98	.8	.12	.335	.69	1.98	33	23.9	.47	7		0	0	0	0	0	0										
14: MX in	0	1	0	10	0	.98	.85	.05	.335	.69	7.9	193	67.5	.85	10		0	0	0	0	0	0										
15: MX out	0	1	0	10	0	.98	.85	.05	.335	.69	7.9	193	67.5	.85	10		0	0	0	0	0	0										
16: MIDGET in	0	1	0	1	0	.9	.8	.05	.475	.78	1	243	57.9	.80	1		0	0	0	0	0	0										
17: MIDGET out	0	1	0	1	0	.9	.8	.05	.475	.78	1	243	57.9	.80	1		0	0	0	0	0	0										
18:																																
19: POLARIS A3	2	16	32	3	96	.55	.8	.50	.2	.59	1	1	1.09	.03	3		19	56	32	32	1	1										
20: POSEIDON C3	19	16	304	10	3040	.55	.8	.25	.04	.34	3.3	2	1.49	.04	14		122	1041	1003	1003	57	45										
21: POS C4	12	16	192	8	1536	.55	.8	.15	.1	.46	2.9	10	7.44	.18	8		154	713	557	557	147	114										
22: TRID C4 in	3	24	72	8	576	.55	.8	.15	.1	.46	2.9	10	7.44	.18	8		58	268	209	209	55	43										
23: TRID C4 out	0	24	0	8	0	.55	.8	.15	.1	.46	2.9	10	7.44	.18	8		0	0	0	0	0	0										
24: TRID D5 in	0	24	0	8	0	.66	.85	.05	.475	.78	5.08	243	68.2	.85	8		0	0	0	0	0	0										
25: TRID D5 out	0	24	0	8	0	.66	.85	.05	.475	.78	5.08	243	68.2	.85	8		0	0	0	0	0	0										
26:																																
27: FB-111	56	1	56	4	224	.3	.8	.10	1	.50	13.5	100	50.0	.74	4		224	112	756		224	112										
28: B-52G	61	1	61	8	488	.3	.8	.10	1	.50	70	100	50.0	.74	9.76		488	244	4270		488	244										
29: B-52H	90	1	90	8	720	.3	.8	.10	1	.50	70	100	50.0	.74	9.76		720	360	6300		720	360										
30: B-52 CMC in	90	1	90	20	1800	.3	.8	.05	.2	.59	70	137	54.9	.78	20		360	1853	6300		2461	989										
31: B-52 CMC out	0	1	0	20	0	.3	.8	.05	.2	.59	70	137	54.9	.78	20		0	0	0		0	0										
32: B-1B pen in	0	1	0	8	0	.3	.8	.10	1	.50	125	100	50.0	.74	16		0	0	0		0	0										
33: B-1B pen out	0	1	0	8	0	.3	.8	.10	1	.50	125	100	50.0	.74	16		0	0	0		0	0										
34: B-1B CMC in	0	1	0	22	0	.3	.8	.05	.2	.59	125	137	54.9	.78	22		0	0	0		0	0										
35: STEALTH	0	1	0	5	0	.3	.8	.10	1	.50	50	100	50.0	.74	5		0	0	0		0	0										
36:																																
37: ICBM total			1034		2134												1275	1636	2099	593	507	370										
38: SLBM total			600		5248												352	2078	1801	1801	260	203										
39: BOMBER total			297		3232												1792	1769	17626		3893	1705										
40: FORCE TOTAL			1931		10614												3419	5483	21526	2393	4661	2270										

USSR FORCES: AGGREGATE MEASURES											AGGREGATES PER WHD/VEHICLE											AGGREGATES PER SYSTEM										
	PLAT- FORMS	SNDV PER 1984	SNDV PLTF	WHDS PER SNDV	WHDS AVLB	REL/ PEN	CEP nMI	YLD (MT)	EMT	THWT/ PYLD Kib	CMP	ECMP	2000 PSI	KILLS	SWS	YLD (MT)	EMT	THWT/ PYLD (Kib)	MIRV THRWT (Kib)	CMP (100)	ECMP (100)											
9:SS-11	570	1	570	1	570	.85	.7	.75	.95	.98	2.2	2	1.19	.03	2	542	560	1254		10	7											
10:SS-13	60	1	60	1	60	.85	.75	.1	.6	.84	1.5	1	.532	.01	1.36	36	51	90		0	0											
11:SS-17	150	1	150	4	600	.95	.75	.25	.75	.91	6.83	13	9.42	.22	6.83	450	545	904	904	79	57											
12:SS-18 one	24	1	24	1	24	.95	.75	.15	2.5	1.58	16.5	82	40.3	.66	18.7	60	38	396		20	10											
13: mirv in	284	1	284	10	2840	.95	.75	.15	.5	.79	16.7	28	18.7	.39	18.7	1420	2255	4743	4743	795	532											
14: mirv out	0	1	0	10	0	.95	.75	.15	.5	.79	16.7	28	18.7	.39	18.7	0	0	0	0	0	0											
15:SS-19 mirv in	330	1	330	6	1980	.95	.75	.15	.55	.82	7.53	30	19.8	.41	8.53	1089	1623	2483	2483	591	391											
16: mirv out	0	1	0	6	0	.95	.75	.15	.55	.82	7.53	30	19.8	.41	8.53	0	0	0	0	0	0											
17:SSX24 MXsky	0	1	0	10	0	.95	.8	.1	.5	.79	8	63	39.0	.65	10	0	0	0	0	0	0											
18:PL-5 mobile	0	1	0	1	0	.95	.8	.1	.5	.79	3	63	39.0	.65	2.72	0	0	0		0	0											
19:																																
20:YANKEE	27	16	432	1	432	.4	.7	.5	.75	.91	1.6	3	2.28	.06	1.45	324	393	691		14	10											
21:DELTA I	18	12	216	1	216	.4	.7	.5	.75	.91	1.8	3	2.28	.06	1.63	162	196	389		7	5											
22:DELTA II	4	16	64	1	64	.4	.7	.5	.75	.91	1.8	3	2.28	.06	1.63	48	58	115		2	1											
23:DELTA III in	11	16	176	3	528	.4	.7	.3	.5	.79	2.5	7	4.75	.12	3	264	419	440	440	37	25											
24:DELTA III out	0	16	0	3	0	.4	.7	.3	.5	.79	2.5	7	4.75	.12	3	0	0	0	0	0	0											
25:TYPHOON	4	20	80	9	720	.4	.7	.3	.1	.46	7.5	2	1.66	.04	9	72	334	600	600	17	12											
26:																																
27:BEAR	100	1	100	1	100	.1	.8	.1	.8	.93	25	86	46.8	.72	8.29	80	93	2500		86	47											
28:BISON	45	1	45	1	45	.1	.8	.1	.5	2.24	12	293	50.0	.80	7	225	101	540		132	26											
29:BACKFIRE	70	1	70	1	70	.1	.8	.1	.2	.59	26	34	24.3	.48	5.54	14	41	1820		24	17											
30:BLACKJACK	0	1	0	12	0	.1	.8	.1	.2	.59	36	34	24.3	.48	16	0	0	0		0	0											
31:	----		-----		-----											----	-----	-----	-----	-----	-----											
32: ICBM total	1418		1418		6074											3597	5071	9870	6130	1495	996											
33: SLBM total	64		968		1960											878	1401	2235	1040	78	53											
34: BOMBER total	215		215		215											319	234	4860		242	98											
35:FORCE TOTAL	1697		2601		8249											4786	6706	16965	9170	1814	1144											

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